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MANAGEMENT HANDBOOK

To Aid Emergency Expansion of

Dehydration Facilities for Vegetables and Fruits

VOLUME II

ONION SUPPLEMENT

A Phase II Preparedness Study

Prepared at the Request of
Office of the Quartermaster General
Department of the Army
Washington, D. C.

By

Western Regional Research Laboratory
Bureau of Agricultural and Industrial Chemistry
Agricultural Research Administration
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TABLE OF CONTENTS

Tables

Illustrative Material

FIELD OF HARVESTED ONIONS

(Courtesy of Ferry-Morse Seed Company)

CHAPTER I

BASIC ASSUMPTIONS

Foreword

The planning of a dehydration plant for meeting national emergency needs should take full cognizance of the information and suggestions given in Volume I of this Handbook. This set of plans for an onion dehydration plant is based upon the principles set forth in that portion of the Handbook.

Product Desired

The plant covered by this section of the Handbook is designed to produce dehydrated onion flakes (Type I) in accordance with the Military Specifications "Onions, Dehydrated" (MIL-O-3028) dated 8 August 1949. It will be possible for this plant to produce dehydrated onion slices (Type III) without the addition of any major items of equipment; dehydrated onion powder (Type II) could be produced by the addition of suitable grinding, screening, and packaging equipment.

Bases for Operations, Facilities, and Cost Estimates

A. Location of Plant

Inasmuch as most of the onion dehydration during World War II and subsequently for commercial markets has been done in California, these estimates are based on a plant located in central California. The general plan, design, and operations are applicable, however, to plants located in other areas.

B. Operating Basis

Design and cost estimates are based on an operation of three 8-hour shifts per day, six days per week, and 150 operating days per year (July through December). The labor rates used in this set of plans are as follows:

Class Labor	Hourly Rate
1	$1.90
2	1.73
3	1.55
4	1.42
5	1.34
6	1.18

C. Raw Commodity Used

It has been assumed that the Southport White Globe variety of onions will be used exclusively in the proposed plant. This variety of onions is available directly from the harvesting fields for three to four months, and from common storage for two to three months additional.

Provision has been made in the cost estimates for raw commodity prices ranging from $20 to $80 per ton delivered to the plant.

D. Plant Capacity and Yields

This plant has been designed to process 100 tons of raw onions per day. It is assumed that the preparation line will operate 20 hours per day and have a nominal capacity of 5 tons of raw onions per hour. The dehydration tunnels and bins will operate 24 hours per day to dry the material prepared in 20 hours. The screening and packaging lines will operate 20 hours per day.

The over-all shrinkage ratio for this plant is assumed to be 9 : 1. The industry has reported ratios ranging from 7 : 1 to 16 : 1 for Southport White Globe onions. Some of the principal factors responsible for this wide range in over-all shrinkage ratios are: (1) solids content of onions (depending largely upon cultural and growing conditions), (2) deterioration of onions in storage (the higher ratios mentioned resulted largely from the use of onions badly deteriorated in storage), (3) damage of onions from sunburn (caused by leaving the harvested onions exposed to the sun), (4) rain damage while onions are in the ground or after they have been dug but left in the fields, (5) maturity of onions, (6) onion size, and (7) processing methods used in dehydrating onions.

On the basis of a 9 : 1 over-all processing shrinkage ratio, 100 pounds of size-graded raw onions entering the processing line yields 11.1 pounds of dried products consisting of:

(1) 7.4 pounds of dehydrated onion flakes (Type II)
(two-thirds of total dehydrated products)

(2) 3.7 pounds of dehydrated onion "fines"
(one-third of total dehydrated products)

This study has assumed that all of the onion "fines" produced are a by-product of no value. Doubtless there will be some civilian demand and possibly some utilization by the Armed Forces; any net income from the sale of onion "fines" would reduce the cost for producing the dehydrated onion flakes.

E. Storage Space

Storage space in the plant building is provided in this set of plans for handling a raw onion supply equivalent to 5 to 7 days of plant operation. In addition, space has been provided for holding a 30-day production of packaged and cased dehydrated onion flakes plus a 10-day supply of empty cans and cases, or any combination of these items. No provision has been made, in this set of plans, for storing the "fines". Unless a use is found for the "fines", they will be hauled away with the plant wastes.

F. Waste Disposal

It has been assumed that the wastes from this plant will be hauled away at a cost of $2 per ton.

CHAPTER II

SUPPLY OF RAW ONIONS

Characteristics Desired in Raw Onions to be Dehydrated

The military specifications (Onions, Dehydrated, MIL-C-3028, dated 8 August 1949) require that the onions used for dehydration shall be clean, sound, and mature, and shall be white, yellow, or red varieties having prominent pungent characteristics. Varieties which yield a bitter or mild dehydrated product shall not be used. Onions shall be of U. S. No. 1 grade, except for size, as defined in the Standards issued by the U. S. Department of Agriculture in effect on the date of invitation for bids. In general, these requirements state that a given lot shall consist of onions of similar varietal characteristics, which are mature, fairly firm, and fairly well shaped, and which are free from doubles, splits, bottlenecks, and scallions. The onions shall be generally free from damage caused by seedstems, tops, roots, sunscald, sunburn, sprouting, freezing, peeling, disease, insects, mechanical or other means, and shall be free from dirt or other foreign matter. The allowable percentage tolerances for defects are stipulated in the Standards.

Characteristics that are important in the onions used for dehydration are given below:

(1) The onion bulb should be high in solids content. This quality has an important bearing on the cost of raw material per pound of dehydrated product. The solids content varies widely from variety to variety of onions, and depends also upon cultural practices and growing conditions. Other factors being equal, the unit cost of dehydrated product made from low solids content onions will be much higher than the unit cost of the product from onions of high solids content.

(2) A large bulb is desired for economy in preparation for dehydration. A minimum diameter of two inches is commonly required.

(3) The onion should be high in pungency since the dehydrated product is to be used primarily as a flavoring agent. The residual pungency in the dehydrated product bears a close relation to the original pungency of the raw material. 1/ Generally, the mild varieties are low in solids and the pungent varieties are high. Onions having a bitter flavor should be avoided.

(4) The bulb should have a white flesh and preferably a white skin. Yellow and red varieties may be used, but a pure white product has been preferred by the military.

(5) The bulb should have good storage quality in order that the onions may be kept in common storage for two or three months after the harvest season, thus permitting an extension of the processing season.

1/ Caldwell, J. S., and others. Varieties of Onions for Dehydration. Beltsville, Md. U. S. Bur. of Plant Indus., Soils, and Agric. Engin. 1943. 19 p. processed.

Suitable Dehydration Varieties and Commercial Production Data

The dehydration plant should be located where there is a large enough supply of suitable raw material within economical hauling distance to supply its needs over a long operating season. The processor should choose a variety, or varieties, of onions for which there is an adequate available seed supply and with maturing seasons to fit his requirements. He should choose highly productive varieties which meet the quality requirements and which are available at economical prices. He should be certain that the chosen varieties are suitable for the area.

Some of the characteristics desired in onions for dehydration (such as high pungency, high solids content, white flesh, proper size and shape, and good storage quality) are not generally related to latitude, temperature, or length of growing season. The variety of onion (and strain of that variety) is the most important factor in determining these characteristics. A variety should be grown under conditions that have been proved good for that particular variety. For example, early varieties are grown successfully only in the low latitudes of the southern part of the U. S. where the plants will get their growth and form bulbs in the relatively short days of early spring. If these early varieties are grown farther north, however, with the necessary later planting dates, the plants will mature early as a result of the longer days, and the bulbs at maturity will be of marble size. On the other hand, late varieties grown in the south, and planted when conditions are best in the area, will produce a seed stem before the daylight hours are sufficient for proper bulb formation.

During World War II about 90% of the onions used for dehydration were grown in California, and most of the remainder came from Idaho. Since World War II, nearly all of the dehydrated onions come from California. Only in California and Idaho, and to a limited extent in Utah, Nevada, eastern Oregon, and parts of Colorado, has there been sufficient experience in onion production for dehydration to serve as a basis for a discussion. There are doubtless areas in other States that could grow onions successfully for dehydration, but each area must be carefully appraised before a dehydration plant is established there. The following descriptions of varieties and growing conditions are based primarily on California conditions and experience.

The Southport White Globe is the variety most widely used for dehydration; it was extensively used by the military forces in World War II. This variety, when grown especially for dehydration, is seeded from November 15 through April and harvested from July through October. Dehydrators normally do not operate past January 1 on stored Southport White Globe onions. The yield of this variety in California is high -- good growers achieving over 20 tons per acre. This variety is a strongly flavored, medium-hard onion, of from 2 to 2-1/2 inches average diameter. It is considered a mid-season to late variety. It has good storage stability. It has a low shrinkage ratio (averaging about 9 : 1 under good conditions). After dehydration, the Southport White Globe retains an adequate amount of flavoring power.

The Southport Yellow Globe has been used successfully for dehydration and its characteristics are much like those of the Southport White Globe.

The Sweet Spanish onion is used for dehydration in Idaho and because it matures late it is sometimes used for extending the dehydration season in California. It was dehydrated for use by the military during World War II. Onions of this variety usually are low in solids content and weak in flavoring power. Their use for dehydration is in part due to (a) the large size of the bulbs (which favors lower peeling and trimming costs), (b) the very high yields per acre which are ordinarily obtained, and (c) the relatively low price. Certain strains of Sweet Spanish onions are reported to give quite favorable dehydration shrinkage ratios and to retain good flavoring power in the dehydrated product.

The suitability of other varieties has not been sufficiently established by commercial dehydration experience. Although some have been successfully dehydrated commercially, there is insufficient knowledge available of the actual results achieved to allow the making of definite recommendations. Any discussion of the suitability of other varieties, therefore, is based primarily upon a knowledge of what characteristics are desirable for dehydration and upon limited laboratory tests made by various research agencies.

If a prospective dehydrator is faced with the necessity of building a plant in an area not already proved suitable for dehydration operations and expects to use a variety of onion not known to be entirely satisfactory for dehydration, he will be faced with the major task of proving the suitability of both the area and the variety before he undertakes establishment of the plant.

Several varieties are considered by some investigators to have characteristics suitable for dehydration. Among these are the White Creole, Red Creole, Ebenezer, and White Portugal. These are highly flavored onions, and have been found to make excellent dried products. Further experimental work must be done on these varieties, however, as there are conflicting opinions regarding the suitability of these onions for dehydration. Present dehydrators do not usually use these varieties, the reason being expressed that they are either too small, have low yields in the fields, or discolor during dehydration.

The White Creole is a very early maturing onion grown in the southern parts of Louisiana, Texas, and California. (The red strain was dehydrated to some extent during World War II.) The chief potential value of the White Creole to the industry is the fact that it matures during the period of May 1st to June 15th, a period otherwise devoid of suitable commercial production. It has been found to have the highest solids content of any of the common varieties -- exceeding 16%. It is a hard white onion with very good keeping qualities; it will keep in storage from one season to the next provided the storage conditions are favorable. It is adapted only to the southernmost parts of the United States (such as Louisiana and Imperial Valley of California) as it requires these climatic conditions to produce the proper size for processing.

The Ebenezer is an early variety, maturing in Central California in July. It is probably the onion variety most widely consumed throughout the U. S. It has high solids content, strong flavoring power, and good storage qualities. It has been used to a limited extent for dehydration. The principal disadvantages of the Ebenezer are the pale yellow color of the outer fleshy scales and the relatively poor harvest yields obtained.

The White Portugal is a very late maturing onion. It is very pungent, white, and has good storage stability. The solids content is reasonably high. The yield per acre is usually low.

The chief characteristics of the principal onion varieties are summarized in Table I. Table II gives important factors concerning the production of these principal varieties. Onion production, yields, and prices for the principal producing states are presented in Table III.

Procurement Problems

A. Supply of Seed

The problem of an adequate seed supply for a large increase in acreage of onions for dehydration possibly can be met with some temporary adjustment in varieties used. Onion seed will keep and remain viable from two to four years under favorable

storage conditions. Another important factor is that onion seed can be planted immediately after it is harvested and cleaned. For these reasons the large seed houses have been able to maintain considerable flexibility in onion seed supply. Onion seed production by varieties, for 1948-51, is given in Table IV.

There is a present shortage of Southport White Globe seed because of the popularity of this variety as green onions and for dehydration purposes, and because of cultural difficulties encountered in growing the seed. The Ebenezer variety, on the other hand, has a seed that is very easy to produce; it is the most widely used variety throughout the country; and there are ample seed stocks.

A 100-ton per day dehydrating plant will need about 15,000 tons of field-run onions during a 6-month operating season. About 5,000 pounds of seed would be needed to plant the approximately 1,200 acres of land needed to produce this quantity of onions. This is based upon an average yield of 12.5 tons and the use of three to four pounds of seed per acre. (Approximately 100,000 pounds of seed would be needed to supply as much onions as were dehydrated during all the World War II period.)

B. Soil, Fertilizer, and Cultural Requirements

Fundamental to onion growing is a suitable soil. Onions are among the most shallow-rooted of the vegetables and therefore it is necessary to have the plant nutrients and the necessary moisture at optimum conditions near the surface of the soil. Onions will grow well on sandy loam, silty loam, peat, or muck soils, but not on coarse, gravelly, or clay soils. The soil should be finely pulverized and free of debris.

The onion grower should be aware of symptoms of nutritional deficiency in the plants and be prepared to correct any hunger signs in the crops. Nitrogen, phosphorous, and potassium often need to be added to the soil in varying amounts. On peat soils, however, onions make little or no response to the application of nitrogen. On mineral soils the application of manure to the preceding crop is important when onions are to be planted.

Onions may be propagated by several means depending upon the expected use of the commodity, the particular climatic condition of the locality, and the relative costs of various operations. Direct seeding in the field is perhaps the simplest and cheapest method of any, and is usually done wherever conditions permit. Planting dry sets has many advantages in growing green onions for early markets, but has not been extensively used for onions to be dehydrated. The transplanting of seedlings ("transplants" or "green sets") to the field is in increasing usage, particularly for areas having cheap labor.

Cultivation and weeding are necessary during the early growing period. The trend is toward the use of herbicides for weed control. 1/

C. Harvesting and Transporting of Onions

When the bulbs ripen, the leaves weaken just above the bulb and fall over. A field of onions does not mature uniformly and it is a matter of expert judgment as to the proper time to harvest. A field is mechanically harvested by loosening the bulbs in the soil by running a blade or cutter below the bulbs, the bulbs then are pulled by hand, and the tops removed. The bulbs are placed in sacks or crates and

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1/ Knott, J. E., Vegetable Growing, pp. 206-213. Lea & Febiger, Philadelphia (1949).

allowed to cure and dry out for a few days before marketing or storage.

Onions harvested while slightly immature will better retain their outer skin, and are less likely to sprout when curing, than those pulled later. However, fully mature bulbs are more solid and better suited to dehydration. For these reasons it is important for the dehydrator to exercise control over the time of harvesting the onions, and have representatives who are competent to recognize the optimum conditions for harvesting in each field.

Onions harvested for dehydration are usually put in burlap sacks holding about 80 pounds. Hauling from the fields to the plant is customarily done by truck and/or trailer. Some rail transporting is done, but is mostly used for bringing onions from out-of-plant storage to the dehydrator. Since fresh onions are not highly perishable, the plant operator has some permissible latitude in scheduling the deliveries of the fresh commodity to the plant.

Table V and Figure 1 give planting and harvesting seasons for the principal onion producing states.

D. Storing and Conditioning Raw Onions

Differences in the storage quality of onions is in a large measure due to varietal differences and to the stage of bulb development at the time of harvest. Storage quality is also dependent upon conditions during and immediately following maturity, length of time between harvesting and storing, the actual storage conditions, and the length of the storage period.

For maximum storage stability a variety of onion should be grown in the environment to which it is best adapted. A very early maturing onion will not store well if grown in the northern states, nor will a late maturing onion keep well if grown in southern Texas or the California Imperial Valley.

Under California conditions, Southport White Globe Onions can be processed directly from the field from July 1st to October 31st. Usually during part of October and for the rest of the processing season it is necessary to draw material supplies from storage. Some late onions may be stored successfully until March. There is a great variation in the storage stability of different varieties of onions. Most desirable storage conditions are 32° F. and a relative humidity of not over 70% to 75%; the cost of providing this type of storage may be prohibitive, however. Onions are often successfully stored in well-ventilated water-proof sheds provided the temperature and humidity conditions can be met. In the rainless, late summer of California, onions may be stored out of doors in sacks placed only one tier deep or on pallets so as to provide plenty of air circulation. It is important that onions be dry when they are put into storage. If conditions do not permit the onions to be harvested dry and to be field cured, the onions must be cured artificially before they are placed in storage.

E. Competing Outlets for Fresh Onions

Factors that are important in determining the differences in prices paid for onions in the various producing areas include:

(1) Time of harvest

(2) Proximity of the growing area to large markets

(3) Quantity of onions available for market

(4) Varietal characteristics of onions grown in the area

Of the onions grown for the fresh market, about 85% are not especially suitable for dehydration because they are of varieties that are weak in pungency and high in water content. Another 10% of the market onions are of the yellow or brown varieties which are not suitable for dehydration because they tend to have a bitter flavor.

The major areas of onion production in New York and Michigan are located close to large metropolitan markets and the average prices are relatively high because the bulk of production is absorbed by nearby fresh markets. The large production in Texas is sold at high prices because the commodity comes on the fresh market in very early spring when there is no competition from such states as New York and Michigan. California onions produced for dehydration would need to meet the competition from the fresh markets of such large centers of population as Los Angeles and San Francisco, particularly during May and June, but the later season production can be very readily expanded to meet the needs for dehydration.

The relatively large production in Idaho, Oregon, and Colorado is far from large fresh markets and the competition for the onions from these sources should not be particularly serious to the dehydrator. Average onion prices in these three states are the lowest of any of the important producing states. Prices in Idaho are especially low. Yet the dehydrator cannot take advantage of this low-priced raw material, for the preponderant production from these States is of the Sweet Spanish varieties having low solids content which would largely off-set the advantage of low price. This statement applies to the bulk of the production in these States, but does not apply necessarily to any special high solids strains.

Because of the possibility of quantity production of varieties best suited to dehydration above the needs of competing outlets, California has been the chief source of onions for dehydration. For the past ten years, one of the largest onion dehydrators in California contracted for onions at prices ranging from $32 to $45 per ton and averaging about $39 per ton. During this same ten-year period the open market prices in that territory averaged approximately $50 per ton. The lower prices paid for contracted onions were due, in part, to the dehydrator's paying for the sack and transportation costs.

Other factors also account for part of the difference between lower prices paid for onions for dehydration. The market price is the average of all varieties of onions harvested during all seasons of the year. The contract price is mainly for one variety of onions harvested specifically for dehydration. The advantages to the grower of having a sure outlet for his crop would influence him into contracting at a price lower than he might hope to receive on the open market.

F. Competition with other Crops for Acreage

There are many other crops which have the same soil, water, and fertilizer requirements as onions have. Some of these crops may be used in rotation with onions, and others are in direct competition with onions for the use of the acreage. Lettuce, sugar beets, and potatoes are the cash crops that are most commonly competitive with onions for the use of land in the California onion-producing areas. Very recently the wide expansion of cotton acreage has utilized land which had been used for onion growing or which would otherwise have been available for onions in the event of an increased onion demand by dehydrators. A decrease in the price of cotton would undoubtedly make more land available for onion growing in the Southern San Joaquin Valley of California. Suitable rotation crops — such as cabbage, peas and beans — which leave considerable amount of humus-forming residues and have penetrating roots, should alternate with onions.

G. Considerations in Obtaining Onions of Proper Grade

It will be advisable and often necessary for the dehydrator of onions to contract for his raw material supply prior to planting time. The fresh market or commercial storage should never be relied upon to meet adequately his entire requirements.

The contracts under which the crops of onions are grown, harvested, and delivered to the dehydrator should emphasize size and quality. This can be done in a number of ways. Since onions for dehydration must meet certain requirements, these requirements should be included in the contract with the grower with provisions for specific deductions in the contract price when defects exceed a specified tolerance. In actual practices, many onions have been purchased "field run" from reliable growers and found to yield an excellent dried product. A well-qualified and energetic field man, employed by the dehydrator, can assist growers in producing onions of the required quality by timely advice as to fertilizer needs, planting dates, irrigation practices, and weed and insect control. Proper cultural and irrigation practices on the approach to maturity should be enforced through field inspections to insure proper quality and maturity.

The dehydrator will probably find it to his advantage to furnish the seed to the grower, thus assuring the use of the desired variety.

A number of factors in raw material procurement affect the time of year that an onion dehydration plant operates and the length of the processing period. The very early onion crop from any area usually commands a very high fresh market price, and is seldom available, even on a contract basis, for processing. Furthermore, many of these early-season onions are not suitable for dehydration purposes. For example, in California early onions are usually available May 1 but the main dehydration season does not start until July 1; peak dehydration production is during the period July 1 through October when the harvesting and quality of fresh onions are at the maximum; processing can continue during November and December when good quality onions are available from common or open-shed storage; from January through April dehydration can be done only by using stored onions that may be expensive and may have deteriorated in storage.

Plans for expanding production of dehydrated onions should be made as far in advance as possible. After the important question has been answered, from a military standpoint, as to the part of the country in which the dehydration plant is to be located, there are several vital points that affect getting sufficient raw commodities to attain and maintain substantial production of a dehydration plant. Early planning is essential, as the supply of seed for the desired varieties may be limited, and it may be 12 to 24 months before the seed companies can obtain it. It may be necessary, during the interim period, to utilize other acceptable varieties. Establishment of grower contracts should be done well ahead of the next growing season, as it may be necessary to convert acreage from other use. It will be necessary to make long-range commitments, in an emergency period, for such necessary items as farming tools and equipment, fertilizers, insecticides, sacks and boxes, and transportation of the harvested commodities to the plant. To extend the processing period to the maximum, it will be necessary to arrange suitable storage for the onions after the principal harvesting season is past.

TABLE I
CHARACTERISTICS OF PRINCIPAL VARIETIES OF ONIONS

Variety	Relative Dry Matter Content 1/	Flavor	Color of Skin	Usual Size Diameter inches	Usual Size Weight oz.	Firmness	Relative Storage Quality	Other Common Names
Highly Flavored Varieties								
Globe Varieties:								
Southport White Globe 2/	High	Medium strong	White	2.0-2.5	2.3-3.7	Medium hard	Good	Giant White Globe, Silver Globe, White Globe
Southport Yellow Globe 2/	High	Medium strong	Yellow	2.0-2.5	2.2-4.5	Medium hard	Good	Golden Globe, Ideal Yellow Globe
Brigham Yellow Globe	Medium	Medium strong	Yellow	2.0-2.5	2.3-4.5	Medium hard	Very good	----------
Yellow Globe Danvers	Medium	Medium strong	Yellow	2.0-2.5	2.1-3.7	Medium hard	Good	Colorado Bronze Globe, Oregon Yellow Globe
Early Yellow Globe	Low	Medium strong	Yellow	2.0-2.5	1.7-3.5	Medium	Good	----------
Ohio Yellow Globe	Medium	Medium strong	Yellow	2.0-2.5	2.1-3.5	Medium	Good	Michigan Globe Danvers, Michigan Yellow Globe
Mountain Danvers	Low	Medium strong	Brownish yellow	2.0-2.5	1.7-3.3	Medium	Good	Mountain Globe, Special Yellow Globe
Southport Red Globe	Medium	Medium strong	Red	2.0-2.5	2.3-4.5	Medium hard	Good	Crimson Globe, Ohio Red Globe
Other Varieties:								
White Creole 3/	Very high	Very strong	White	2.0-2.5	1.6-3.2	Hard	Very good	White Keeper, White Wonder
Red Creole 3/	Very high	Very strong	Red	2.0-2.5	1.6-3.2	Hard	Very good	Creole, Louisiana Creole
Australian Brown 3/	High	Very strong	Brown	2.0-2.5	2.1-3.5	Hard	Very good	Australian Brown Globe, Brown Spanish
Ebenezer 3/	High	Very strong	Brownish yellow	2.0-2.5	1.7-3.4	Medium hard	Good	Japanese, Long Keeping
White Portugal 3/	High	Very strong	White	2.0-2.5	1.6-3.2	Medium hard	Good	American Silver Skin, New England White
Red Wethersfield	Medium	Medium strong	Red	2.5-3.0	3.5-5.3	Medium soft	Good	Dark Red Beauty, Extra Large Red Wethersfield
Mild Varieties								
White Sweet Spanish 2/	Very low	Mild	White	3.0-3.5	7.4-12.0	Medium	Fair	----------
Sweet Spanish	Very low	Mild	Yellow	3.0-3.5	7.4-12.0	Medium	Fair	Mountain Sweet Spanish, Yellow Valencia
Crystal Wax	Low	Mild	White	3.0-3.5	4.9-7.1	Soft	Poor	Bermuda White, Crystal White
Yellow Bermuda	Low	Mild	Yellow	3.0-3.5	4.9-7.1	Soft	Poor	White Bermuda
Early Grano	Low	Very mild	Yellow	2.5-3.0	3.5-5.6	Soft	Poor	Babosa, Early Sweet Spanish
California Early Red	Low	Very mild	Red	2.5-3.0	3.2-5.3	Soft	Poor	Red Italian Tripoli, Red 21
Italian Red	Low	Very mild	Red	2.5-3.0	5.6-11.3	Soft	Very poor	Torpedo, Bottleneck

1/ Dry matter content has been found to range from 5.5% to 16.5%
2/ Variety used by dehydrators in 1951.
3/ Variety reported by some investigators satisfactory for dehydration.

Sources: Caldwell, J. S., and others. Varieties of Onions for Dehydration. Beltsville, Md. U. S. Bur. of Plant Indus., Soils, and Agric. Engin. 1943. 19 p. processed.
Cruess, W. V., and MacKinney, G. The Dehydration of Vegetables, Berkeley, 1943. (Calif. Agric. Expt. Sta. BUL. 680).
Magruder, R., and others. Description of Types of Principal American Varieties of Onions. Washington, D. C., 1941. (U. S. Dept. of Agric. MISC. PUB. 435).
Magruder, R., and others. Storage Quality of the Principal American Varieties of Onions. Washington, D. C., 1941. (U. S. Dept. of Agric. CIRC. 618).

TABLE II
FACTORS PERTAINING TO THE COMMERCIAL PRODUCTION OF THE PRINCIPAL VARIETIES OF ONIONS

Variety	Principal Growing Areas	Range of Adaptation 1/	Maturity 2/	Relative Productivity Per Acre
Highly Flavored Varieties				
Globe Varieties				
Southport White Globe	Central Calif. and Michigan	Wide	Mid-season	High
Southport Yellow Globe	Central Calif. and Michigan	Wide	Mid-season	High
Brigham Yellow Globe	States North of 36° Parallel	Wide	Mid-season	High
Yellow Globe Danvers	States North of 36° Parallel	Fairly Wide	Late	Medium
Early Yellow Globe	Massachusetts and New York	Wide	Mid-season	High
Ohio Yellow Globe	Peat soils 3/	Narrow	Mid-season	High
Mountain Danvers	Rocky Mountain States 4/	Narrow	Mid-season	Medium
Southport Red Globe	States North of 36° Parallel	Wide	Late	High
Other Varieties				
White Creole	Southern parts of Louisiana, Texas, and California	Narrow	Very early	Low
Red Creole	Southern parts of Louisiana, Texas, and California	Narrow	Very early	Low
Australian Brown	California Salinas Valley	Narrow	Mid-season	Low
Ebenezer	Atlantic States and Minnesota	Fairly wide	Early	Medium
White Portugal	States North of 36° Parallel	Wide	Mid-season	Medium
Red Wethersfield	States North of 36° Parallel	Wide	Late	High
Mild Varieties				
White Sweet Spanish	Colorado, Idaho, Oregon	Fairly wide	Very late	Very high
Sweet Spanish	Colorado, Idaho, Oregon	Fairly wide	Very late	Very high
Crystal Wax	Southern parts of Texas & Calif.	Narrow	Very early	Medium
Yellow Bermuda	Southern parts of Texas & Calif.	Narrow	Very early	Medium
Early Grano	Texas	Narrow	Very early	High
California Early Red	Central California	Narrow	Early	High
Italian Red	Central California	Narrow	Late	Very high

1/ Adaptability to various growing conditions and localities.

2/ Varieties classed according to the minimum photo period or length of daylight per day required to produce normal bulbs:

12.0 hours - Very early
13.0 hours - Early
13.5 hours - Mid-season
14.0 hours - Late
15.0 hours - Very late

3/ Especially muck and peat soils of Great Lake States and of the Sacramento River delta in California.

4/ Especially Colorado; also Oregon.

Sources:

Caldwell, J. S., and others. Varieties of Onions for Dehydration. 19 p., processed. Beltsville, Md., U. S. Bur of Plant Indus., Soils, and Agric. Engin., 1943.

Jones H. A. "Onion Improvement." In: U. S. Dept. of Agric. Yearbook of Agric. 1937. pp. 233-37.

Magruder, R., and others. Description of Types of Principal American Varieties of Onions. Washington, D. C., 1941. (U. S. Dept. of Agric. MISC. PUB. 435).

U. S. Bur. of Agric. Econ. Acreage and Production of Vegetable Seeds, 1950-51. Washington, D. C., Apr. 20, 1951. 8 p., processed.

TABLE III

ONION PRODUCTION, YIELDS, AND PRICES FOR PRINCIPAL PRODUCING STATES
(1940 - 1950)

State and Season	Ten-Year Average - 1940 through 1949				Average Price/Ton		Leading Varieties Grown
	Production (Tons)	Acreage (Acres)	Yield Per Acre (Tons)	Price Per Ton (Dollars)	1949 (Dollars)	1950 (Dollars)	
New York -Total	164,325	14,230	11.6	60.94	70.00	32.00	Ebenezer, Early Yellow Globe and Brigham Yellow Globe
Colorado -Total	129,650	10,450	12.4	40.30	54.00	24.00	Sweet Spanish, and White Sweet Spanish
Texas -Total	120,550	54,300	2.2				
Early Spring	93,650	41,560	2.3	69.48	58.00	46.00	Mostly Yellow Bermuda and Crystal Wax, also Early Grano
Late Spring	26,900	12,740	2.1	65.68	76.00	70.00	Mostly Yellow Bermuda and Crystal Wax
California -Total	99,800	9,800	10.2				
Late Spring	37,100	4,120	9.0	60.08	60.00	36.00	Crystal Wax, Early Grano, and Creole
Late Summer	62,700	5,680	11.0	47.42	60.00	34.00	Australian Brown and Southport White Globe
Michigan -Total	86,475	8,290	10.4	56.70	62.00	34.00	Mostly Southport Yellow Globe, also Southport White Globe
Oregon -Total	64,125	4,310	14.9	42.70	49.60	24.00	Sweet Spanish and Yellow Globe Danvers
Idaho -Total	51,950	3,440	15.1	29.52	32.00	14.00	Sweet Spanish and White Sweet Spanish
Minnesota -Total	39,075	3,890	10.0	50.02	70.00	24.00	Early Yellow Globe, Ebenezer, and Southport Yellow Globe
Louisiana -Total	4,025	1,670	2.4	72.40	80.00	60.00	Red Creole and White Creole
Total of Principal States	760,475	110,380	6.9	-	-	-	
Total for Other States	186,825	20,000	9.3	-	-	-	
Total United States	947,300	130,380	7.3	52.26	58.80	33.60	

Sources:

U. S. Bur. of Agric. Econ. Commercial Truck Crops, Acreage and Indicated Prod., June 1, 1951; Oct. 1, 1951. Washington, D. C., 1951.

U. S. Bur. of Agric. Econ. Commercial Truck Crops for Fresh Market, Acreage ... Annual Summary, 1950. Washington, D. C., 1950.

U. S. Dept. of Agric. Agricultural Statistics, 1950. Washington, D. C., 1951.

TABLE IV

PRODUCTION OF ONION SEED BY VARIETIES 1/

(1948 - 1951)

Variety	1948 (lbs.)	1949 (lbs.)	1950 (lbs.)	1951 2/ (lbs.)
Australian Brown	2,052	1,170	26,799	3,500
Bermuda, White	3,800	40,092	72,964	8,000
Bermuda, Yellow	34,700	120,601	101,979	38,050
Ebenezer	110,964	203,708	288,320	143,285
Early Yellow Globe	68,670	131,165	145,243	30,680
Red Wethersfield	3,942	2,614	20,932	4,900
Southport White Globe 3/	48,465	20,018	63,675	48,602
Southport Yellow Globe 3/	35,282	26,802	18,679	2,800
Sweet Spanish 3/ & Prizetaker	14,714	73,755	135,609	106,430
Pickling Varieties	-	3,100	3,400	5,000
White Portugal	71,822	16,559	45,057	16,650
Yellow Globe Brigham	29,608	79,687	127,067	46,290
Yellow Globe Danvers	11,102	22,760	31,601	17,400
Other varieties	70,230	137,389	244,788	144,274
Total	505,351	879,420	1,306,113	615,861

1/ Production by 130 commercial seed growers who usually have accounted for about 95% of the total commercial seed production in the United States.

2/ Indicated by growers' intentions.

3/ Varieties of onions now being used for dehydration.

Source:

U. S. Bur. of Agric. Econ. Acreage and Production of Vegetable Seeds, Jan. 17, 1950; May 15, 1950; Apr. 20, 1951. Washington, 1950-51.

TABLE V

USUAL PLANTING AND HARVESTING PERIODS FOR ONIONS IN PRINCIPAL PRODUCING STATES 1/

Season and State	Planting Period 2/	Harvesting Period			Growing Districts
		Begins	Most Active	Ends	
Early Spring					
Texas	Oct. 1 - Nov. 30	Mar. 15	Apr. - May	May 31	Lower Rio Grande Valley. (Winter Garden, Laredo, and Coastal Bend areas)
Late Spring					
California	Nov. 1 - Feb. 28	Apr. 1	May - July	Aug. 31	Delta district; San Joaquin and Imperial Valleys
Louisiana	Dec. 15- Jan. 31	May 1	May - June	June 30	LaFourche, Point Coupe, and West Filiciana Parishes
Texas	Jan. 15-Mar. 15	May 1	June - Aug.	Oct. 31	Central, Panhandle, and El Paso Districts
Late Summer					
New York	Mar. 20- Apr. 15	July 1	Aug. - Sept.	Oct. 31	Canastota and Elba Sections; Orange County
Michigan	Apr. 10- May 15	July 1	Aug. - Sept.	Oct. 31	Southern
Minnesota	Apr. 15- Apr. 30	July 1	Sept. - Oct.	Oct. 31	Southeastern and Northwestern
Colorado	Mar. 1 - Mar. 31	July 1	Aug. - Sept.	Oct. 31	Arkansas Valley; Greeley area; Western Slope
Idaho	Mar. 1 - Mar. 31	July 1	Aug. - Sept.	Oct. 31	Snake River Valley
Oregon	Mar. 25-Apr. 15	July 1	Aug. - Sept.	Oct. 31	Malheur County; Willamette Valley
California	Feb. 1 - Apr. 30	July 1	Aug. - Sept.	Oct. 31	San Joaquin and Salinas Valleys; Delta and Tulelake areas; southern California

1/ Sources:
U. S. Bur. of Agric. Econ. Commercial Truck Crops for Fresh Market: Usual Planting and Harvesting Dates and Principal Producing Areas by Seasonal Groups and States. Washington, D. C., 1951.
U. S. Bur. of Agric. Econ. Usual Planting and Harvest Time for Major Field Crops and Commercial Vegetables for Fresh Market. Washington, D. C., 1948.

2/ Planting dates refer to the period of transplanting or setting to the fields where such is the usual practice.

Note: These periods are based on average dates, and may vary considerably from year to year.

CHAPTER III

PLANT PROCEDURES AND FACILITIES

This section gives pertinent information concerning the operating procedures and the facilities required for the onion dehydration plant. The information is coded and presented in accordance with the classification key given in Appendix D ("Operation Classification Code") of Volume I. The accompanying flow-sheet, drawings of equipment and facilities, and other illustrative material have been labeled in accordance with this same classification. (Note: This same classification key has been used in compiling the "Cost of Facilities" and "Total Production Costs", and thus affords a useful cross-reference system for identifying or discussing any phase of the operations and/or costs.)

The operational procedures and other facilities needed for this proposed onion dehydration plant are presented in accordance with the attached flow-sheet (Figure 2). A floor-plan (Figure 3) is given to show the space and arrangement required for the facilities.

100 -- RAW MATERIALS

The problems and methods of procuring a suitable supply of onions for a dehydration plant have been discussed in "Supply of Raw Onions" elsewhere in these plant plans.

It is assumed that the raw onions will be purchased from growers under contract. The onions will be field-graded to remove foreign material and the very small or otherwise undesirable onions. The onions will be sacked (80 pounds per sack) for transportation to the plant.

200 -- MANUFACTURING OPERATIONS

210 -- Raw Material Handling

211 -- Weighing

It is assumed that the truck-loads of onions will be weighed at the plant (whether from the fields or from storage).

212 -- Unloading and storing at the plant

A 5- to 7-day supply of raw onions will be kept at the plant to assure smooth operation of the plant. Pallets have been provided for holding a 10-day supply of onions on pallets at the plant. No provision has been made for palletizing onions held in storage buildings for future use by the plant. Sacks have been provided for handling onions in the field, hauling to the plant, and for holding a 3-months supply for the plant.

SIZE-GRADING ONIONS PRIOR TO PROCESSING

(Courtesy of Basic Vegetable Products, Inc.)

213 -- Feeding to line
214 -- Sizing

The onions received at the plant will contain a small proportion of high quality onions, under two inches in diameter, that can be marketed at a favorable price. The onions under two inches in diameter are separated by the sizer and pass over a short inspection belt. The high quality onions are removed and sacked. The remaining small onions are put in tote boxes for later processing.

The preparation line can process onions that contain a reasonable proportion of the small sizes. Thus the small onions in the tote boxes can be fed into the preparation line at such a rate that a proper balance of small onions is maintained.

The manner in which the small onions are handled will vary greatly depending partly on these factors: (1) the market demand for the high quality small onions, (2) the proportion of small onions in the lots received, (3) the ability of the preparation line to absorb the small sizes of onions, and (4) the demand for dehydrated onions versus the supply of raw onions.

Some companies run the small size onions through the preparation line without rooting or topping them. The dehydrated product is ground into powder for civilian trade.

215 -- Handling and loading sacks on trucks

The empty sacks are cleaned (and repaired if necessary) and returned to the original point of use, i. e., rotated in use.

220-230 -- Preparing

A diagrammatic sketch of the "preparation line" for the proposed onion plant is given in Figure 4.

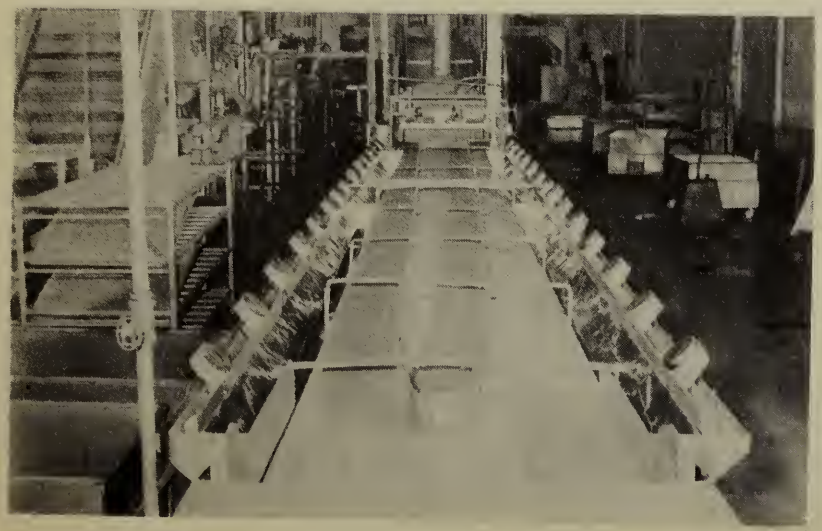
221 -- Washing
223 -- Peeling
224 -- Trimming, coring, rooting, topping & inspecting
225 -- Washing

Four different methods are used in the onion dehydration industry today for these operations:

1) Rooting and topping with fixed rotary saws followed by high pressure washing to remove the outer skin ("paper shell"). The onions are size-graded (214) and each size run separately through the processing line. The individual onions are positioned by hand on a rotating turret which conveys the onion between two rotating circular saws. The saws cut off the top and root ends of the onions. As the distance between the saws does not change for each onion, the amount cut off depends on the length of the onion. After the tops and roots are removed, the onions are passed through high pressure washers with vigorous roll action so that most of the outer skin ("paper shell") is removed. (Original equipment for the rooting and topping operation was built by Urschel Laboratories, Valparaiso, Indiana, but has been modified appreciably by one of the dehydration companies to bring it to its present acceptable form.)

(Right)
Onion washer with roller brushes
and High-Pressure Water Sprays →
(Courtesy of Western Canner and Packer)

(Below)
Typical Installation of "Hydrout" Corers
(Courtesy of Magnuson Engineers)



Advantages: Can turn out an excellent product with low equipment investment and with a minimum requirement for labor.

Disadvantages: Greater material loss, as this method results in 8% to 15% loss by weight, whereas other commercial methods average 3% to 10% loss in this operation.

2) Flame peeling, high pressure washing, and rooting and topping with rotary corers. The onions are size-graded (214) and each size run separately through the processing line. The first unit in the line is the flame peeler, which burns off the outer "paper shell" and hair roots of the onions. After peeling, the onions are washed with high-pressure water, and sorted. They are next topped and cored by water-driven rotary knives -- a manual operation requiring each end of an onion to be pushed against a small rotating knife.

Advantages: When properly operated with good raw material, this method gives an excellent product with low raw material loss and low labor requirements.

Disadvantages: Flame peelers have been developed and used by only one dehydrating company; the units are not available from any equipment manufacturer; the equipment is quite expensive; and considerable experience is required for successful operation.

3) Washing, rooting, and topping with rotary corers. Onions that are too small to be processed economically are removed by size-grading (214). The acceptable onions are washed under sprays in a roll washer to remove any loose outer "paper shell". Each end of the onion is then positioned by hand against a water-driven rotating knife that removes the top and root ends.

Advantages: This type of coring machine is commercially available; it represents a medium investment in equipment, has low labor requirements, and results in a low raw material loss.

Disadvantages: Any failure to remove the tough "paper shell" makes slicing of the onion more difficult; onions that have green tops or heavy root-fibers may block the rotary knives.

4) Washing, rooting, and topping by hand trimming. Onions that are too small to process economically are removed by size-grading (214). The acceptable onions are washed under sprays in a roll washer, and the tops and roots removed with hand knives.

Advantages: Has the simplest equipment set-up; has low material loss.

Disadvantages: Requires most labor of the four methods considered; leaves most of the outer "paper shell" on the onions.

Suggested Method for Proposed Plant. The proposed plant uses a combination of methods (3) and (4) so as to give a wider range of adaptability (than either method alone) for handling onions of different maturity and condition. Two preparation tables are set up parallel to each other: one is equipped with rotary corers for rooting and topping (as for Method No. 3), and the other is set up for hand operations only (as for Method No. 4). Onions are diverted to one table or the other according to their condition -- Method No. 3 is used when the onions are sufficiently dry and mature, and Method No. 4 is used when the onions are

green. It may be advantageous to put half of the total number of rotary corers (Method No. 3) on each of the tables, and to feed the incoming onions simultaneously to both tables. In this way, each worker can use whichever method is required for the particular batch of onions coming through the line to remove skins which have been loosened. Following these operations, the onions are given a high-pressure washing.

No matter what procedures are used, not all of the "paper shell" will be completely removed prior to the slicing operation. The remaining "paper shell" is usually removed by aspirating the product after the drying operation.

Water-driven rotary corers are the only type that is being used by present operators. Blade design is an important factor in the successful use of this piece of equipment. Some work has been done to develop mechanically-driven rotary knives, but apparently such devices have not been used for onions. Water-driven rotary knives require higher water pressure for onion rooting and topping than when used for similar operations on other vegetables.

The installation of mechanical counters for use by each worker on the rooting-and-topping operation should be considered. An incentive payment plan, based on the number of onions prepared (in addition to the regular base pay) should materially increase production, especially after the operators have gained experience.

226 -- Cutting (slicing)

Specifications require that the onions shall be sliced to give pieces not less than 1/8 inch thick nor more than 1/4 inch thick. Operators usually prefer the thinner slices, as this permits a higher drying rate. Good slicing is essential for good drying. Slicing at right angles to the vertical axis of the onion gives the best drying rate. When slicing is done parallel to the vertical axis, "slabs" are cut at the outer surfaces of the onion. These "slabs" dry very slowly. Unfortunately, no slicing machine is available at present that positions the onion so that all cutting is at right angles to the vertical axis.

"Slabs" also may be formed by the rolling of the onion as it is being cut. For the most successful operation, it is necessary to keep the slicing blades sharp and to have the blades traveling rapidly as they cut the onions.

The equipment used for this operation may be either standard kraut cutters or slicers designed especially for onions. The latter run at much higher speeds, confine the cutting knives to the outer part of the rotating head, and have fewer knives. As the onions in the proposed process will still have considerable tough "paper shell" when they come to the slicer, a specially built unit has been selected for the plant proposed herein.

A magnet may be installed in the line, just preceding the slicing operation, for removing any loose pieces of iron and steel which may have fallen into the material.

240 -- Drying

241 -- Tunnel drying

241.1 -- Tray loading

Trays may be loaded directly under the slicer, or the onion slices may be spread on a belt running under the slicer and dumped onto the trays. When the onions are loaded directly on the trays, deflector vanes are used under the slicer to aid in distributing the onions across the trays. Hand labor is used to clear the onions off the frame boards of the trays. When a belt is used between the slicer and the trays, spreading on the belt may be accomplished with a rotating rake. Sliced onions may be kept off the side frame-boards of the trays by a mechanically actuated chute at the end of the spreading belt and kept off the center cross-piece of the trays by a dividing strip at the end of this belt.

Tray loading has been figured at 1.25 pounds per square foot, as this seems to be an average figure for present practice in industry. The rate at which the trays move under the slicer should be variable so that it can be changed to allow for the variation in quantity of onions going to the slicer.

241.2 -- Tray stacking

The loaded trays are then stacked on the trucks by a mechanical stacker. (Trays are stacked both manually and mechanically in the industry.)

241.3 -- Weighing

Prior to entering the drying tunnel, each loaded truck is weighed on scales built underneath a section of the track.

241.4 -- Tunnel operating

Onions are particularly sensitive to heat damage; the drying time is the longest of any vegetable considered in this Handbook.

Onions are dried commercially in truck-and-tray tunnel type driers employing cross-flow of air. Present operating companies use one-, two-, or three-stage tunnels, with the trend in new construction favoring the two-stage design. Tunnels may be either side-fired or overhead fired; fuel is either gas or oil.

The higher entering-air temperatures necessary in single-stage countercurrent driers to obtain satisfactory throughput may damage the product as it approaches dryness. Two-stage drying, however, affords a means of using fairly high temperatures in the initial drying (first stage) while the onion is still high in moisture content and not so susceptible to heat damage. As the commodity approaches dryness (second stage) the drying is done at lowered temperatures which do not deleteriously affect the product. Three-stage tunnels may offer some additional advantages over either the single- or two-stage types, but their operation is more complex.

In keeping with the current trend in onion dehydrator construction, this set of plans suggests the use of a two-stage tunnel drier. The following data have been selected as good design and operating characteristics for a 2-stage onion drying system:

		Primary Stage	Secondary Stage
1.	Direction of air flow	Parallel	Counter current
2.	Air velocity between trays	1,000 ft./min.	600 ft./min.
3.	Volume of air per tunnel	25,000 c.f.m.	15,000 c.f.m.
4.	Type of firing	Direct	Direct
5.	Type of fuel	Gas	Gas
6.	Inlet air temperature 1/	160°F.	135°F.
7.	Tray loading	1.25 lbs./sq.ft.	--
8.	Size of trays	3 ft. x 6 ft.	3 ft. x 6 ft.
9.	Number of trays per truck	25	25
10.	Trucks in tunnel during operation	6	16
11.	Moisture content of product entering	87%	50%
12.	Moisture content of product leaving	50%	7%
13.	Drying time	3 hours	8 hours

To meet the production requirements under the foregoing operating conditions, eight 2-stage tunnels (four double units) are recommended for a 100-ton per day onion plant. Major design features for the 2-stage tunnels are shown in Figures 5 and 6.

The heating capacity of the combustion chambers is based on mild climatic conditions. If the plant is to operate in a cold climate, the size of the combustion chambers must be calculated to fit the anticipated climatic conditions.

The number of trays and trucks proposed is for a 3-shift operation. If it is desired to use only two shifts on the preparation line and to operate the tunnels continuously, more trays and trucks will be required for holding the freshly sliced onions waiting to be put in the tunnels. The sliced onion must not be held too long before drying, however.

1/ Many onions can be dried satisfactorily with temperatures of 180°F. to 190°F. in the primary stage and 140°F. in the secondary stage, with a drying time of about 9 hours usually being realized. The use of these higher temperatures, when conditions permit, help give assurance of maintaining steady rates in all the various operations and of satisfactorily handling peak loads.

241.5 -- Tray unloading and stacking

Semi-automatic tray-scraping, as discussed in Chapter X of Volume I, is provided in these plant plans.

241.7 -- Tray washing

In industry, the frequency of tray washing varies from three or four times a season to every time the trays are unloaded. For this plant it is proposed that the trays will be washed once a week by a special crew working on Sundays when the plant is not in operation. Tray washing will be done on the tray conveyor between the slicer and the tray stacker. High pressure water will be provided by the pump on the onion washer (225) that precedes the slicer. Banks of spray nozzles, both above and below the tray level on the conveyor, can be set up when trays are to be washed.

248 -- Bin drying

248.1 -- Bin loading
248.2 -- Bin operating
248.3 -- Bin unloading

Current industry practice is predominantly to use fixed bins for completing the drying operation for onions, with only one dehydrator using portable bins for this purpose. Discussions with various operators, however, indicate a belief that portable bins would be preferred as pointed out in Chapter X of Volume I.

One onion dehydrator uses dehumidified hot air for bin drying, two use indirect heating of the air, and one uses direct air heating with gas. Dehumidified air offers an advantage on humid days (over 70 grains per pound of dry air). The conclusion has been reached that dehumidified air is not essential in an emergency plant in dry climates, but its use may be justified in humid areas as in some portions of the East and South.

The proposed onion plant uses portable bins and a bin room designed on the basis of the following data:

1) Air flow rate through bins - 25 c.f.m. per sq. ft. of area

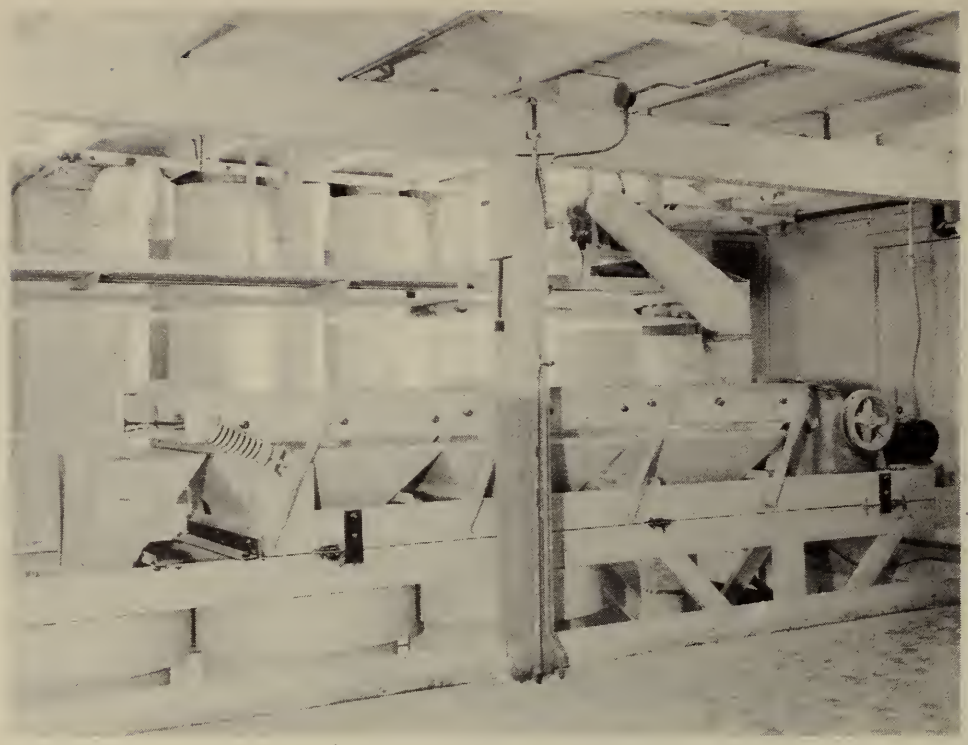
2) Inlet air temperature to bins - 120°F.

3) Drying time - 30 hours

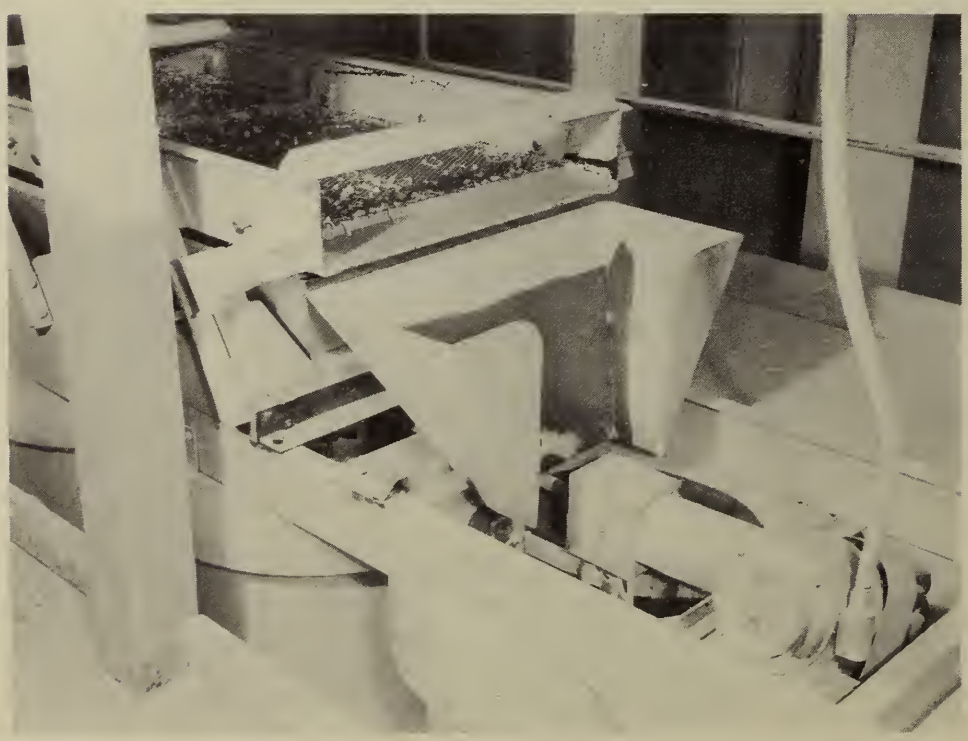
4) Bulk density of dried onions (7% to 8% moisture content) - 8 to 12 lbs. per cu. ft.

5) Depth of material in bins - 4 feet

The air temperature cited is good conservative practice. It may be necessary to exceed this temperature on humid days to maintain the drying schedule.



Shaker-screen and aspirator equipment for removing "fines" and "paper-shell" from dehydrated onions
(Courtesy of Gentry Division, Consolidated Grocers, Inc.)



Close-up view of shaker-screen and the feed hopper to aspirating equipment
(Courtesy of Gentry Division, Consolidated Grocers, Inc.)

The trays of dried onions coming from the tunnels are emptied into a hopper; an elevator and a conveyor transport the dried onions into a portable bin in the bin room. Figure 7 illustrates a suitable portable bin in which to complete the onion dehydration.

The bins are connected to the hot-air ducts along the wall of the bin room to accomplish the final drying. Figure 8 shows a proposed bin room layout. Space is provided for 26 bins on the two heating ducts. An additional 8 bins are provided in the equipment list for loading, unloading, and holding of dried onions.

250 -- Screening and Inspecting

252 -- Screening

The military specifications require that not more than 2% by weight of the dehydrated product may pass through a U. S. Standard sieve containing 14 meshes to the inch (0.046-inch openings). Screening is therefore required to remove the material that is too fine in size to meet these requirements. A good screening job is necessary as additional "fines" may be generated when the flakes are pressed into the cans. In some plants the screening operation has an additional function: dividing the dried onions into various size fractions to be fed to separate aspirators, thus permitting more efficient aspirating.

Approximately one-third of the total dehydrated product is "fines" that must be removed. In the event that a civilian outlet is found for this by-product, any net return from sales of the "fines" will reduce the cost of the flakes. As the Quartermaster Corps is not at present interested in the onion powder, the "fines" have been considered a waste material in this set of plans.

253 -- Aspirating

The "preparation" operations as carried out by present-day dehydration practices leave widely varying amounts of "paper shell" which must be removed from the product. This residual "paper shell" from the "preparation" operations is removed by aspiration. To achieve more efficient aspirating results, the dried onions may be separated into three size-fractions (252); screen sizes should be readily changeable so that this size-grading of material going to each aspirator is adjustable.

Industry uses two types of aspirating equipment: (1) aspirating legs working over a perforated belt or at the end of a belt, and (2) disk aspirators. Conditions under which these units are being used in industry have not permitted a good comparison of the relative merits of the two types. The disk type is more expensive, but probably will do a sufficiently better job to justify its cost. These units also fit better into the proposed layout for the screening and aspirating operations (Figure 9). This layout should have extra building height, which will permit a much better equipment arrangement than can be attained otherwise.

A gate is provided at the discharge point of the last aspirator so that the larger pieces may go to the "cutter" or to "finished product" as desired. The latter would be the method of operation if it were desired to produce Type III (sliced) dehydrated onions.

254 -- Cutting and screening

The cutting and screening operation is not required to produce onion flakes conforming with the military specifications, as the specifications do not limit the maximum size of the dehydrated onion piece. It is advisable, however, to put the dehydrated product through this operation, as it affords three advantages:

1) Pressing of the required weight of product into the cans can be done more easily

2) Less "fines" are generated in pressing the dehydrated onions into the cans

3) Partially dried "slabs" may be separated from the dehydrated product by screening of the "cut" product. (The partially dried "slabs" are not reduced in size by the "cutting" operation, whereas the fully-dried onion pieces (being brittle) are reduced in size. After passing through the cutter, the "slabs" are retained on a course screen, while the pieces of dehydrated onions will be sufficiently reduced in size to pass through the screen.)

The "slabs" from the cutting and screening operation are returned to the bins for further drying, and the dehydrated onions are recycled through the first screening and aspirating equipment. This recycling procedure permits shorter total drying periods in the bins, because each bin-drying period does not have to proceed to the point that the "slabs" are completely dried in a single drying operation.

255 -- Inspecting

After the screening and aspirating operations, the flakes are inspected for discolored pieces, core fragments, "paper-shell," etc. The inspection is done while the dehydrated and properly sized product is carried along on continuous conveyor belts going to the packaging operation.

260 -- Packaging and Packing

261 -- Filling, packing, and sealing

Equipment to do the filling and weighing varies from plant to plant in the onion dehydration industry. The rate of handling the cans is low, and expensive or complicated equipment has not been justified. More manual operations are permissible in packaging onion flakes than on most can-filling lines. At least two general methods may be considered:

(1) The approximate weight is pressed into the can, the can is transferred to a scale, and the quantity of onions in the can is adjusted to the required weight. The pressing operation can be done mechanically or manually. When the pressing is done mechanically, the can is positioned under a cylindrical chamber through which a hydraulically-operated piston travels. The chamber and the can are filled with approximately the required weight of dehydrated onions; the piston then presses the flakes into the can, leaving some space in the top of the can for final adjustment of weight.

(2) An extension collar is placed in the can, the exact weight put into the can and collar while on a scale, and the onions are pressed into the can by a hydraulic plunger. The collar then can be removed, and the can is ready for sealing.

It is suggested that the proposed plant use the second method. The first step in the operation is to heat the dehydrated onions under a bank of lamps to make them more pliable. Approximately a 2-to-1 compression is required (i.e., reduce the space occupied by the dehydrated flakes to one-half its normal volume) to get 2-1/2 pounds into a #10 can. Compression is done with a vertical plunger actuated by a hydraulic cylinder.

Can-closing is done in the conventional manner. Cans should be purchased with lithographed labels as required in the specifications. The date is stamped on the can at the time of packaging.

The military specifications require that the processor place in each can a leaflet giving cooking directions.

262 -- Case forming, filling, sealing, marking

Specifications permit the use of either wood boxes or fiberboard cartons of definite types; the military bids and contracts will specify the exact types of packing to be supplied by the dehydrator. Present-day dehydrators use either mechanical or manual casing operations.

270 -- Warehousing and Shipping

In keeping with the current trend, the proposed plant utilizes pallets for handling and storing of the finished product in the warehouse.

GENERAL FACILITIES

The requirements for other needed facilities have been discussed in Volume I, and the information will not be repeated here. The principal "general" facilities for the onion plant are listed in the "Cost of Facilities" for this proposed plant; included are items for utilities, maintenance and repairs, inspection and control, miscellaneous plant facilities, automotive, and administrative facilities and supplies.

325 -- Waste disposal

"Preparation" wastes (220-230) may be removed from the plant by mechanical conveying, water fluming, or manual operations. It is quite convenient to remove most of the "preparation" waste by water-fluming -- the method chosen for the proposed layout.

An assumption has been made that the solid wastes will be hauled to a dump. Land-filling is being tried by some plants as a means of disposing of onion wastes, but the results of such trials are not yet available.

For a plant located outside of town, disposal of liquid wastes preferably will be into large running streams or irrigation ditches if local, state, and federal laws permit. Waste water also may be disposed into seepage ponds, lagoons, or waste land.

BUILDINGS AND GROUNDS

Buildings and grounds for an onion dehydration plant should conform with the general requirements described in Volume I under "Plant Location" and "Selection of Plant Procedures and Facilities". An onion plant, such as the one proposed, requires a minimum of 3 acres of land, and preferably should have 5 to 7 acres. On-the-grounds storage facilities, that probably could be utilized advantageously by this plant, will further increase the requirement for land.

Selection of a plant site for onion dehydration should take into consideration one additional major factor that is not present in the other dehydration plants considered in this Handbook, namely the odor factor. Preferably, the site should not be in town, but should be in open country with no farm houses on the down-wind side for a mile or more. Choosing a proper location will materially diminish the possibilities of nuisance abatement lawsuits.

Figure 3 shows a suggested plant layout. A receiving area in the main building has been provided for holding a 4- to 5-day supply of raw material. If the plant is located in a cold climate this area probably should be increased. The "preparation" area is separated from the "receiving" area to minimize the noise and dust. Floor drains should be provided across the "preparation" area, along the tray stacking and slicing line down to the turntables, and for each of the two transfer tracks.

Space is provided in front of the primary tunnels for storing loaded trucks of freshly sliced onions. (This storage space is needed if it is desired to operate the "preparation" line on a two-shift basis and the tunnels on a three-shift basis.) The space at the discharge end of the tunnels is smaller, based on the premise that the dried onions will be removed from the trucks within a short time after leaving the secondary tunnel.

The sizing, inspection, and packaging area requires three stories in the proposed layout. The area also includes space for installation of equipment for handling the onion powder, as it is believed that any operator will want to be in a position to process this material.

OPTIONAL EQUIPMENT

248 -- Dehumidifier

A dehumidifier could be used advantageously when operating under highly humid atmospheric conditions, or to shorten the bin-drying time. This unit is planned for a two-stage bin drying operation. The same bin room layout as shown in Figure 8 is used. Dehumidified heated air is blown through duct "B". The air coming from the bins on this duct is collected in a hood over the "B" bins, and conveyed to the fan supplying air for duct "A". First-stage bin drying is done on duct "A"; second-stage drying is done on duct "B".

CHAPTER IV

COST OF ONION DEHYDRATION FACILITIES

Cost Summary

100 -- RAW MATERIAL PROCUREMENT FACILITIES		
130 -- "Field Grading" Equipment	$ 9,800	
170 -- "Crates, Boxes, & Sacks" (burlap sacks)	36,000	
Total for RAW MATERIAL PROCUREMENT FACILITIES		$ 45,800
200 -- MANUFACTURING OPERATIONS FACILITIES		
210 -- "Raw Material Handling" Equipment	29,370	
220-230 -- "Preparing" Equipment	34,470	
240 -- "Drying" Equipment	153,365	
250 -- "Screening & Inspecting" Equipment	26,885	
260 -- "Packaging & Packing" Equipment	13,995	
270 -- "Warehousing & Shipping" Equipment	2,000	
Total for MANUFACTURING FACILITIES		260,085
GENERAL FACILITIES		
320 -- "Utilities" Equipment	26,490	
330 -- "Maintenance and Repairs" Equipment and Supplies	15,000	
380 -- "Inspection & Control" Equipment	4,000	
390 -- "Miscellaneous Plant" Equipment	5,200	
400 -- "Automotive" Equipment	3,500	
690 -- "Office & First Aid" Equipment & Supplies . . .	4,500	
Total for GENERAL FACILITIES		58,690
Total for Plant Equipment (TABLE I)		364,575
Total for Buildings & Grounds (TABLE II)		235,000
Construction Engineering Fees		30,000
TOTAL COST FOR ITEMIZED PHYSICAL FACILITIES FOR ONION DEHYDRATION PLANT		$629,575

Critical Materials in the Equipment for a 100-Ton per Day Onion Dehydration Plant

Material	Estimated Total No. of Pounds in Equipment	Percentage of Total Weight of Critical Materials
Iron and Steel	270,000	98.36
Copper	2,500	0.91
Zinc	800	0.29
Stainless Steel	200	0.07
Tin	100	0.04
Rubber	900	0.33
	274,500	100.00

Disclaimer Statement

The designation of any manufacturer or brand-name equipment does not imply a specific recommendation by the Department of Agriculture. Such inclusion means only that these particular items have been found satisfactory for the purpose indicated; other sources and items may prove equally satisfactory. Additional information concerning suggested manufacturers of equipment may be found in "Additional Sources of Information" (Volume I, Appendix C).

TABLE I—PLANT EQUIPMENT FOR A 100-TON PER DAY ONION DEHYDRATION PLANT

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
			100 -- RAW MATERIAL PROCUREMENT FACILITIES			
130 -- Field Grading						
a.	Field graders: To remove dirt, waste, etc.; to separate processing onions from under-sized onions; to permit visual inspection of each field laborer's work	Paramount Model 1436 (3,000 lbs. each)	Mounted on pneumatic tires: rod type belt with 7/8" spacing to eliminate trash; sizing section equipped with mesh belt of desired openings; includes gasoline engine for driving belts	4	$2,300	$ 9,200
170 -- Crate, Box, & Sack Expense						
a.	Burlap sacks: For handling onions in field, plant, and storage	--	"Used" burlap sacks; 80-lbs. capacity	200,000	0.18	36,000
			Sub-total			$ 45,200
Allowance for Freight Charges (factory-made equipment)			-- 12,000 lbs. at 5¢/lb.			600
Allowance for Installation Charges -- 25% of equipment			cost plus freight			none
			TOTAL COST OF "RAW MATERIAL PROCUREMENT" FACILITIES			$ 45,800
			200 -- MANUFACTURING OPERATIONS FACILITIES			
210 -- Raw Material Handling						
211 -- Weighing (at plant)						
a.	Truck scales: To weigh incoming loads of raw onions (not required for plants having access to public scales)	Fairbanks-Morse Code 6512 (14,000 lbs)	Platform 10' x 60'; capacity 50 tons; equipped with type registering beam; includes structural steel for timber deck. Cost includes $350 installation charge by manufacturer (and does not include pit)	1	$3,750	$ 3,750
b.	Pit & housing for scales	--	Estimated cost for constructing pit and housing for scales	-	--	3,000
212 -- Unloading & storing (at plant)						
a.	Lift trucks: To unload and move palletized raw onions and other palletized loads within the plant	Yale Model KG 51 T-40-U (7,300 lbs each)	2-ton capacity; gasoline engine	2	4,100	8,200
b.	Pallets: For handling raw onions within plant	--	Wood; 48" x 60"; double-faced	2,000	4	8,000
213 -- Feeding to line						
a.	Elevator: Serves as dumping point for sacked onions; elevates onions to sizer	FMC 1/ Model 15-E Figure 430 (1,200 lbs)	All steel construction; feed hopper, elevator and draper; 30" wide and 4'10" discharge height; constructed of round steel rods carried by side chain; complete with 1 h.p. motor	1	950	950
214 -- Sizing						
a.	Sizer: To remove onions under 2" in diameter	FMC Grabill Chain Sizer (300 lbs.)	Wood frame construction; sizing chain (2" mesh) 30" wide; 4'8" feed height; 1/2 h.p. motor	1	440	440
b.	Conveyor (sorting): For inspection of onions under 2" diameter	FMC Figure 5030 (1,000 lbs)	24" wide x 10' center-to-center rubber belt sorting conveyor; divided center section for sort-outs; steel frame construction; complete with 1 h.p. motor	1	1,275	1,275
c.	Bagger: Feeds onions under 2" diameter to bags (for fresh market)	FMC No. 385,001 (35 lbs)	With mesh bag head and dial	1	365	365

1/ Food Machinery & Chemical Corp.

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
d.	Tote boxes: For holding size-graded onions in plant	--	Wood; 4' x 4' x 3'	50	$ 20	$ 1,000
			Sub-total			$ 26,980
Allowance for Freight Charges (factory-made equipment)			-- 32,000 lbs. at 5¢/lb.			1,600
Allowance for Installation Charges -- 25% of equipment cost plus freight ($3,160) 2/						790
	Total Cost of "Raw Material Handling" Equipment					$ 29,370
220-230 -- Preparing						
221 -- Washing						
a.	Washer: Preliminary washing of onions	Paramount Model 572 (1,500 lbs)	Steel construction; elevator with flights attached to rubber belt; longitudinal rollers with rubber fingers; complete with 1/2 h.p. motor	1	$1,500	$ 1,500
224 -- Trimming, coring, rooting, topping & inspecting						
a.	Conveyor: To move onions to topping & rooting operations	FMC Figure 5030 (1,600 lbs)	Steel frame construction; 24" wide x 25' center-to-center rubber belt distributing conveyor; adjustable metal shear gates to discharge product to 2 peeling tables; 1-1/2 h.p. motor	1	1,875	1,875
b.	Trimming & coring tables: To convey onions for topping & rooting, & to remove trimmed onions & cuttings	FMC Figure 9318 (4,500 lbs each)	Merry-go-round peeling tables consisting of 3 parallel 12" wide x 42' long center-to-center rubber belt conveyors; top of outer belts and return of inner belts on same level; outer belts for conveying onions to be topped & cored & having divided lanes for cuttings; inner belt to be raised so that return side acts as a merry-go-round return for over-flow from outer belts; top side for conveying peeled product to discharge point; all steel frame construction; complete with 3 h.p. motor	2	5,655	11,310
c.	Coring machines: To remove top and root ends of unpeeled onions	Magnuson Engineers Model F Hydrout (10 lbs ea.)	Rotary knife driven by water at 200 p.s.i. pressure; rubber cover for positioning onion	32	60	1,920
d.	Booster pump: To provide water pressure for operation of coring machines	FMC Peerless Type 1-1/2 TUT (1,300 lbs)	Centrifugal; 60 g.p.m. at 200 p.s.i.; complete with 15 h.p. motor	1	860	860
e.	Conveyor: To provide for inspection of trimmed onions & to convey inspected onions to washer	FMC Figure 5030 (1,700 lbs)	24" wide x 30' center-to-center rubber belt collecting conveyor; steel frame construction; complete with 1-1/2 h.p. motor	1	1,925	1,925
225 -- Washing						
a.	Washer: To provide final high pressure washing of trimmed onions	FMC Figure 9317 (2,500 lbs)	Roller washer 42" wide x 7' long center-to-center; all steel frame; draper of 3" diameter steel rollers carried on side-chain; 5' hooded washing section with drain pan and high pressure sprays; complete with 1 h.p. motor	1	2,100	2,100
b.	Booster pump: To supply high pressure water for washing operation	FMC Peerless Type 1-1/2 TUT (1,800 lbs)	4-stage; to deliver 90 g.p.m. at 216 p.s.i.; complete with base & coupling, and 25 h.p. motor	1	1,200	1,200
226 -- Cutting (slicing)						
a.	Elevator: To elevate onions to slicers	FMC Figure 8657 (800 lbs)	12" wide x 9' discharge height; cleated rubber belt elevator; 1/2 h.p. motor	1	1,215	1,215
b.	Slicer: To slice onions to desired thickness	Magnuson Engineers (700 lbs)	Rotary slicer specially designed for onions; stainless steel runner and contact parts; radial curved knives	1	2,250	2,250

2/ Equipment cost based on F.O.B. manufacturer's price plus allowance for freight charges (5¢/lb.)

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
c.	Hood & fan: To remove odors from areas of slicing & tray-loading operations	Custom built	10' x 18' galvanized sheet metal hood; equipped with fan & motor capable of moving 2,500 c.f.m.	1	$ 400	$ 400
			Sub-total			$ 26,555
Allowance for Freight Charges (factory-made equipment) -- 22,000 lbs. at 5¢/lb.						1,100
Allowance for Installation Charges -- 25% of equipment cost plus freight ($27,255)						6,815
	Total Cost of "Preparing" Equipment					$ 34,470
240 -- Drying						
241 -- Tunnel drying						
241.1 -- Tray loading						
a. & b.	Conveyor & spreader: To convey trays under slicer for loading sliced onions on trays uniformly and to convey loaded trays to tray stacker	Custom built (1,800 lbs)	6' x 24' chain-driven tray conveyor	1	2,000	2,000
241.2 -- Tray stacking						
a.	Tray stacker: To stack loaded trays on trucks	Knipschild (4,000 lbs)	Loaded trays are lifted vertically from tray belt and moved horizontally until positioned over empty truck, then stacked to desired height; fully automatic	1	3,600	3,600
241.3 -- Weighing						
a.	Scales: To weigh loaded trucks of onions	Toledo Model 31-1921 FE (2,000 lbs)	Dial type indicating system; 2,600 lbs. capacity. Installed in pit with platform level with floor; 76" x 54" platform. Extension level permits location of dial column out of path of trucks	1	980	980
241.4 -- Tunnel operating						
a.	Trays: To hold sliced onions during drying	Custom built	6' x 3'; wood	6,000	3	18,000
b.	Tunnel driers: To dry sliced onions to approximately 7% moisture	Custom built (See Figs. 5 & 6)	Twin tunnel; each side having two stages with parallel flow in primary stage and counter flow in secondary stage; with necessary control equipment, trackage, trucks, etc.	4 twin tunnels	--	110,000 3/
241.5 -- Tray unloading & stacking						
a.	Tray scraper: To remove dried onions from trays	Knipschild (1,500 lbs)	A revolving wire brush loosens the onions from tray, and onions fall into a hopper	1	1,400	1,400
241.6 -- Elevating & conveying						
a.	Elevator: To lift dried onions from scraper to conveyor feeding the portable drying bins	FMC Fig. 541 (1,800 lbs)	Gooseneck conveyor-elevator; discharge height 14 feet; 12" wide buckets; 1 h.p. motor	1	825	825
b.	Conveyor: To move dried onions from elevator to portable bin loading station	FMC Fig. 5030A (1,500 lbs)	18" wide x 25' center-to-center rubber belt conveyor; complete with 1-1/2 h.p. motor	1	1,835	1,835
			Sub-total			$138,690
Allowance for Freight Charges (factory-made equipment) -- 13,000 lbs. at 5¢/lb.						650
Allowance for Installation Charges -- 25% of equipment cost plus freight ($11,340)						2,835
	Total Cost of "Tunnel Drying" Equipment					$142,175
248 -- Bin drying						
248.1 -- Bin loading						
a.	Drying bins: To hold onions during the final drying stage	Custom built (See Figs. 7 & 8)	4' wide x 8' long x 5' high; sheet metal or plywood construction; mounted on casters and equipped with ring for dumping by means of a hoist; expanded metal screen to serve as false bottom; 10" diameter air inlet duct	34	75	$ 2,550

3/ Cost (installed) - based on estimates from Bloxham Engineering Co., Basalt Rock Co., and other sources

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
248.2	-- Bin operating					
b.	Blowers: To circulate air through the heating coils and drying bins	Sturtevant Silentvane No. 80 Design 10 Class II (900 lbs ea.)	Single width, bottom horizontal discharge; 10,000 c.f.m. at 5" s.p.; including 15 h.p. motor and drive	2	$1,000	$ 2,000
c.	Heating coils: To heat the air going to the drying bins	Aerofin Corp. Type F, Non-freeze Coil Series 80 (400 lbs ea.)	Bank of coils, 3 rows deep, consisting of one section 24 tube face, 4' tubes (No. 82); plus one similar section (No. 81)	2	600	1,200
d.	Ducts: To take air from outside of building, conduct it through fans and heating coils, and to each of 26 drying bin positions (Ducts A & B)	Custom built	Horizontal run laid on floor, 75' length, tapered; 10 sq.ft. cross-section at heater connection; 13 outlets on one vertical face, spaced 5'3" apart, and reduced to 10" diam. collars; vertical run from fan up to horizontal run extending through building wall; including enclosure of fan and heating coils	2	2,000	4,000
248.3	-- Bin unloading					
a.	Hoist: To elevate drying bins for dumping of dried product	Yale & Towne Midget King Electric Hoist (Model No.1E 17 H) (150 lbs.)	Hook type; 2,000 lbs. capacity; 10 ft. lift; 17 f.p.m.; 1 h.p.	1	360	360
			Sub-total			$ 10,110
Allowance for Freight Charges (factory-made equipment) -- 3,000 lbs. at 5¢/lb.						150
Allowance for Installation Charges -- 25% of equipment cost plus freight ($3,710)						930
	Total Cost for "Bin Drying" Equipment					$ 11,190
	Total Cost for "Tunnel Drying" Equipment					142,175
	Total Cost for "Drying" Equipment					$153,365
250	-- Screening and Inspecting					
251	-- Elevating					
a.	Elevator: To lift dried onions from bin dumper to shaker screens on second floor	Link-Belt #202 (3,000 lbs)	Bucket elevator with 6" x 4" buckets; 24' discharge height; complete with 1 h.p. motor and drive	1	$1,860	$ 1,860
252	-- Screening					
a.	Magnet: To remove any particles of iron and steel from dried product	FMC (Cesco) Plate Magnet (20 lbs)	Steel face plate 12" wide; standard model	1	90	90
b.	Shaker screen: To separate "fines" and divide remainder of dried onions into three sized-fractions for aspiration	Link-Belt UP 138 (1,500 lbs)	3' x 8' unbalanced pulley type; three screen sections on single deck; 2 h.p. motor	1	950	950
253	-- Aspirating					
a.	Aspirators: To remove "paper-shell" remaining in the dried product	Sprout, Waldron & Co. - disk aspirator (900 lbs ea.)	21" single disk; with fans and motors attached	3	1,000	3,000
254	-- Cutting and screening					
a.	Cutter: To cut oversize onion rings	Sprout, Waldron & Co. Model 1 1/2J corn cutter (700 lbs)	Rotary horizontal bar cutter with changeable or removable screens	1	850	850
b.	Shaker screen: To separate dried onions from cutter into two sizes: aggregates to be returned to bin driers for further drying, and smaller pieces to go to hopper of elevator feeding the three-section shaker screen	Link-Belt UP 125 (900 lbs)	2' x 5' unbalanced pulley type; one screen section on single deck; 2 h.p. motor	1	600	600

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
255 -- Inspecting						
a.	Cross conveyor: To feed dried onions to the inspection belts	FMC Figure 5030 (1,500 lbs)	24" wide x 20' long center-to-center rubber belt; steel frame construction; with adjustable metal shear gate to discharge product to 2 inspection tables; complete with 1-1/2 h.p. motor	1	$1,675	$ 1,675
b.	Inspection belts: To convey the product past the final inspection station	FMC Figure 5031 (1,300 lbs each)	30" wide x 12' long center-to-center white rubber belt; steel frame construction; complete with 1 h.p. motor	2	1,540	3,080
c.	Cross conveyor: To move the product from the inspection station to the heating belt	FMC Figure 5030 (1,500 lbs)	24" wide x 20' long center-to-center rubber belt; steel frame construction; complete with 1-1/2 h.p. motor	1	1,675	1,675
259 -- Dehumidifying						
a.	Dehumidifier: To provide dehumidified air in the area in which the dehydrated product is handled during all operations from screening to can closing	Pittsburgh Lectrodryer Type CH Size R (8,000 lbs)	Multi-adsorber unit for continuous and automatic reactivation of alumina; 3,000 c.f.m. air flow; complete with 5 h.p. motor	1	6,575	6,575
			Sub-total			$ 20,355
Allowance for Freight Charges (factory-made equipment)			-- 23,000 lbs. at 5¢/lb.			1,150
Allowance for Installation Charges -- 25% of equipment			cost plus freight ($21,505)			5,380
	Total Cost of "Screening and Inspecting" Equipment					$ 26,885
260 -- Packaging and Packing						
261 -- Filling, packing, and sealing						
a.	Conveyor: To move the product under the bank of heating lamps	FMC Figure 5032 (1,200 lbs)	36" wide x 12' long center-to-center rubber belt; steel frame construction; with 10 degree slope and 6 ft. discharge height; complete with 1 h.p. motor	1	$1,580	$ 1,580
b.	Heating unit: To warm the product prior to compression in cans	Custom built	Bank of 36 infra-red lamps, 350 watts each, mounted in insulated hood over conveyor belt	1	200	200
c.	Filling and weighing machine: To deliver the required weight of product into #10 cans	Exact-Weight Model 4103-FM-1-30 (500 lbs)	Vibra-flow feeder; electronic amplifier unit for two rates of flow; with Shadowgraph scale, 4 lbs. capacity	1	840	840
d.	Pressing unit: To compress product sufficiently to get required weight into can	Custom built	Air-operated ram with 10-inch stroke; open height to accommodate 7" can plus 8" collar	1	400	400
e.	Air compressor: To supply compressed air for operation of pressing unit	Curtis Model V-906 (525 lbs)	Two stage; 7.13 cu. ft. air displacement; complete with 1-1/2 h.p. motor and horizontal ASME tank	1	400	400
g.	Closing machine (seamer): To seal the covers on the cans	American Can Co. No. 1 (1,050 lbs)	Semi-automatic machine operated by depressing foot treadle for each seaming operation; includes 1-1/2 h.p. motor	1	850	850
h.	Can conveyor: To move cans from feeding station to filling and weighing machine, to pressing unit, to closing machine, and to discharge table	FMC (650 lbs)	6" wide x 15' center-to-center impregnated fabric belt supported on zig-zag half-round bars; including can stops, discharge table, feed shelf; complete with 1/2 h.p. motor	1	860	860
262 -- Case forming, filling, sealing, and marking						
a.	Case branding machine: To print required marking on cases	Elliott Manufacturing Co. (2,225 lbs)	Automatic machine equipped to handle box shook and flat fibre cases; complete with 1 h.p. motor and variable speed drive	1	1,980	1,980

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
b.	Case sealing machine: To seal top and bottom flaps on cases	Elliott Model A (4,000 lbs)	Fully automatic, with 16' compression section; complete with 3/4 h.p. motor on gluing section and 3/4 h.p. motor on compression section	1	$3,535	$ 3,535
			Sub-total			$ 10,645
Allowance for Freight Charges (factory-made equipment) -- 11,000 lbs. at 5¢/lb.						550
Allowance for Installation Charges -- 25% of equipment cost plus freight ($11,195)						2,800
	Total Cost of "Packaging & Packing" Equipment					$ 13,995
270 -- Warehousing and Shipping						
271 -- Palletizing						
a.	Pallets: For handling empty cans and filled cases	--	Wood; 48" x 60"; double faced	500	$ 4	$ 2,000
	Total Cost of "Warehousing and Shipping" Equipment					$ 2,000
	TOTAL COST OF "MANUFACTURING OPERATIONS" FACILITIES					$260,085
			GENERAL FACILITIES			
320 -- Utilities						
321 -- Water supply						
a.	Water pump: To elevate water from well and to deliver it throughout the plant at required pressure	FMC Peerless Deep well turbine-type pump (5,300 lbs)	8 stages, 10-inch M.A. sheet No. R-1096, Curve 1, for 500 g.p.m. with 285 ft. head at 80 p.s.i. delivery pressure; complete with strainer and 40 h.p. electric motor	1	$2,000	$ 2,000
b.	Chlorinator: To treat the water used in the plant to prevent slime formation and to improve plant sanitation	Wallace & Tiernan Type MASVM-A-421 (1,500 lbs)	Consists of chlorinator, booster pump, differential converter, and main line orifice plate; converter automatically controls flow of chlorine so that the latter is always proportional to flow of water	1	4,500	4,500
c.	Water well: For supplying water sufficient to meet needs of the plant	--	Cost includes digging and casing of well and small housing for pump motor	1	3,000	3,000
324 -- Steam supply						
a.	Steam boiler: To supply steam for bin-drying operation and general plant requirements for tray washing, wash rooms, heating, etc.	Cleaver-Brooks Model IR 400-8 8,900 lbs)	Complete package unit: four-pass horizontal fire-tube boiler with integral channel iron frame and burner assembly; 80 boiler horsepower rating; 125 p.s.i. design pressure; equipped for burning gas and #6 oil; includes 3 h.p. blower motor, 1/3 h.p. spinner motor, and 1/3 h.p. oil supply pump motor, feed pump and condensate tank	1	6,950	6,950
325 -- Waste disposal						
a.	Sewage screen: To separate solids from water in sewage disposal system	FMC Figure 1437 North Sewage Screen (8,000 lbs)	Trunnion type; segment tooth drive; 6-foot screen, #20 mesh bronze wire; 400 g.p.m. capacity; complete with steel tank and 3 h.p. motor	1	3,100	3,100
b.	Elevator: To elevate solid wastes from sewage screen to hopper	FMC Figure 541 (2,100 lbs)	12" wide gooseneck conveyor-elevator with galvanized iron buckets; discharge height 20 ft.; complete with 1 h.p. motor drive	1	880	880
c.	Hopper: To hold solid waste until trucked to dump	Custom built	10' long x 10' wide x 6' height, with sloping sides and discharge gate; elevated for clearance of 12 ft.	1	400	400
			Sub-total			$ 20,830
Allowance for Freight Charges (Factory-made equipment) -- 26,000 lbs. at 5¢/lb.						1,300
Allowance for Installation Charges -- 25% of equipment cost plus freight ($17,430)						4,360
	Total Cost of "Utilities" Equipment					$ 26,490

(Table I Continued)

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
330 -- Maintenance and Repairs 4/						
a.	Maintenance shop equipment: To maintain plant in proper operating condition; to make necessary repairs	--	Includes welding and cutting equipment; drill presses; cut-off saws; sheet metal cutting facilities; hand tools for carpentry, electrical, and metal work; pipe threading and cutting equipment; miscellaneous supplies	-	--	$ 5,000
b.	Maintenance parts & supplies: Standing inventory of spare parts and maintenance supplies to assure continuous operation of the plant	--	Pipe, sheet metal, fittings, electric motors, equipment parts, welding supplies, etc.	-	--	10,000
	Total Cost of "Maintenance & Repairs" Equipment and Supplies					$ 15,000
380 -- Inspection and Control 4/						
381 -- Laboratory testing						
a.	Laboratory equipment and supplies: To do necessary control testing of processing operations and of finished products	--	Apparatus, supplies, tables, hoods, benches, and other facilities needed for tests and control purposes	-	--	$ 4,000
	Total Cost of "Inspection and Control" Equipment and Supplies					$ 4,000
390 -- Miscellaneous Plant Equipment 4/						
a.	Lunch room: To accomodate up to 40 people at a time	--	--	-	--	$ 4,000
b.	Fire-fighting equipment: For emergency use	--	2 - 300-ft. hoses & reels; 2 emergency showers; 8 - 5-gal. extinguisher tanks; 12 hand extinguishers; 12 gas masks	-	--	1,200
	Total Cost of "Miscellaneous Plant" Equipment					$ 5,200
400 -- Automotive Equipment						
a.	Truck: For miscellaneous work to keep plant in proper operation	GMC	1-1/2 ton pick-up truck (delivered price)	1	$3,500	$ 3,500
	Total Cost of "Automotive" Equipment					$ 3,500
690 -- Miscellaneous Administrative Supplies and Facilities 4/						
a.	Office furniture, supplies, and first-aid facilities: For bookkeeping, payrolls, business transactions; personnel work; first-aid	--	--	-	--	$ 4,500
	Total Cost of "Miscellaneous Administrative Supplies & Facilities"					$ 4,500
	TOTAL COST OF "GENERAL" FACILITIES					$ 58,690

TABLE II

BUILDINGS AND GROUNDS FOR AN ONION DEHYDRATION PLANT

	Buildings & Grounds: Suitable buildings and grounds for the onion dehydration plant	--	Includes: land; a building complete with industrial lights, utility and sewer lines within the building, toilet facilities, and loading ramps (or platforms)			
			Buildings -- 47,000 sq. ft. at $5/sq. ft.			$235,000
	TOTAL COST OF BUILDINGS AND GROUNDS					$235,000

4/ Costs indicated for these items include installation costs

LIST OF FACILITIES

(NOTE: THE MANUFACTURERS LISTED ARE NOT RECOMMENDED OVER OTHER MANUFACTURERS OF SIMILAR EQUIPMENT)

Code Number & Operating Steps	Equipment Needed & Function	Acceptable Model (& Ship. Wt.)	Description of Equipment	No.	Cost Per Unit	Approximate Total Cost
			TABLE III			
			OPTIONAL EQUIPMENT FOR AN ONION DEHYDRATION PLANT			
248 -- Bin drying						
	a. Dehumidifier: To provide dehumidified air for circulation through the 13 drying bins in bank "B"	Pittsburgh Lectrodryer Type CH Size U (25,000 lbs)	Multi-adsorber unit providing continuous and automatic reactivation of alumina; without after-cooler; 10,000 c.f.m. air flow; complete with 10 h.p. motor	1	$15,330	$ 15,330
	b. Hood and ducts: To collect air leaving "B" bank bins (See Figure 8) for use in bank "A" bins	Custom built	Approximately 10' x 70' hooded section mounted several inches above top of bins; single exhaust duct	1	3,000	3,000
321 -- Water supply						
	a. Diesel engine: For standby use for operating the well water pump	Fairbanks-Morse Co.	Diesel engine complete with fuel tank and connecting gears for attaching to well water pump. Cost for this standby service is in addition to the cost of pump equipment listed	1	1,500	1,500
322 -- Fuel supply						
	a. Butane storage tank: To supply standby fuel sufficient for 72 hours of plant operation (tunnels, boiler, etc.) in case of emergency shut-down of regular gas supply; also to use in conjunction with "interruptible" type public gas service	--	26,600 gal. horizontal steel tank (standard design) supplied by butane gas distributors; complete with vaporizor, pumps, controls, connecting piping to building, and supporting structure	1	20,000	20,000
394 -- Miscellaneous						
	a. Hand trucks, auxiliary tables, and other similar equipment items	--	--	-	--	5,000
			Sub-total			$ 44,830
Allowance for Freight Charges -- 25,000 lbs. at 5¢/lb						1,250
Allowance for Installation Charges -- (quotations for items include installation costs)						None
			TOTAL COST FOR "OPTIONAL" FACILITIES			$ 46,080

Chapter V

PRODUCTION COSTS
FOR A 100-TON PER DAY ONION DEHYDRATION PLANT

Table I -- Summary of Cost of Producing Dehydrated Onions
(Assuming Different Raw Material Costs and Shrinkage Ratios)

Overall-shrinkage ratio of:		7.5 to 1	9 to 1	15 to 1
Output of finished product per day (lbs.)		17,780	14,815	8,890
		Production Cost per Pound of Product		
Processing Cost - See Table II		$0.3046	$0.3442	$0.5023
Assumed Cost per 100 tons of Raw Material Entering Processing Line				
At $20 a ton	$2,000 a day	$0.1125	$0.1350	$0.2250
30	3,000	0.1687	0.2025	0.3375
40	4,000	0.2250	0.2700	0.4500
50	5,000	0.2812	0.3375	0.5625
60	6,000	0.3375	0.4050	0.6750
70	7,000	0.3937	0.4725	0.7875
80	8,000	0.4500	0.5400	0.9000
Assumed Production Cost 1/ at Various Costs of Raw Material				
At $20 a ton		$0.4171	$0.4792	$0.7273
30		0.4733	0.5467	0.8398
40		0.5296	0.6142	0.9523
50		0.5858	0.6817	1.0648
60		0.6421	0.7492	1.1773
70		0.6983	0.8167	1.2898
80		0.7546	0.8842	1.4023
Estimated Depreciation Charge (See Table X)				
Normal Life Expectancy		$0.0141	$0.0169	$0.0281
Accelerated Write-off		0.0380	0.0456	0.0759

1/ Exclusive of Depreciation Charges

Table II -- Processing Cost Summary Using 3 Different Overall Shrinkage Ratios
(Depreciation not included)
(Onion Dehydration Plant)

	7.5 to 1 (Low)	9 to 1 (Average)	15 to 1 (High)
Input - lbs. per day raw commodity	200,000	200,000	200,000
Output - lbs. per day gross product (4% moisture)	26,670	22,222	13,333
Less - 33% "Fines"	8,890	7,407	4,443
Net yield of flakes - lbs. per day	17,780	14,815	8,890
Total daily processing cost based upon cost calculation using a 9 to 1 overall shrinkage ratio	$5,099	$5,099	$5,099
Adjustment for labor -			
Add 20% of cost of screening, inspection, packaging, and warehousing & shipping ($635)	+ 127		
Deduct 40% of cost of screening, inspection, packaging, and warehousing & shipping ($635)			- 254
Adjustment for packaging supplies -			
Deduct total packaging supply cost based on a 9 to 1 ratio (see Table III)	- 951		- 951
Add cost applicable to shrinkage ratio (pounds x $0.0642)	+ 1,141		+ 571
Adjusted cost 1/	$5,416	$5,099	$4,465
Cost per pound of net product	$0.3046	$0.3442	$0.5023

1/ For purposes of this illustration, it is assumed that all costs per day would be constant for the various yields except the two cost items adjusted. In actual practice, however, costs would be more variable as a result of the different shrinkage ratios

Table II-A -- Calculation of Unit Costs of Processing for Various Shrinkage Ratios
(Assuming constancy of cost except as calculated in Table II)

	7.5 to 1		9 to 1		15 to 1	
	Daily Cost	per Pound	Daily Cost	per Pound	Daily Cost	per Pound
Pounds output per day	17,780		14,815		8,890	
Raw material procurement	$ 93	$0.0052	$ 93	$0.0063	$ 93	$0.0105
Direct labor cost	2,783	0.1565	2,656	0.1793	2,402	0.2702
Manufacturing expense	2,125	0.1196	1,935	0.1306	1,555	0.1749
Packaging supplies and expenses	1,141	0.0642	951	0.0642	571	0.0642
Other manufacturing expenses	984	0.0554	984	0.0664	984	0.1107
General and administrative expenses	415	0.0233	415	0.0280	415	0.0467
Total	$5,416	$0.3046	$5,099	$0.3442	$4,465	$0.5023

Table III -- Processing Cost Summary for Onion Dehydration Plant

Account No.		Table No. Reference	Processing Cost Per 24-hour Operating Day	Processing Cost Per Pound Dry Product
Output of Finished Product Per Day . . . . . (9 to 1 overall shrinkage ratio)		II	14,815 pounds	
800 -- Total Cost of Finished Product . . . . (exclusive of depreciation and raw material purchase price)			$5,099	$0.3442
100 -- Raw Material Cost . . . . . (exclusive of purchase price)		IV	$ 93	$0.0063
120	- Buying Expense		63	0.0043
180	- Federal-State Inspection		30	0.0020
200 -- Direct Labor		V	$2,656	$0.1793
210	- Raw Material Handling		276	0.0186
220-230	- Preparing		1,179	0.0796
240	- Drying		566	0.0382
250	- Screening and Inspecting		316	0.0214
260	- Packaging and Packing		264	0.0178
270	- Warehousing and Shipping		55	0.0037
300 -- Manufacturing Expenses			$1,935	$0.1306
310	- Indirect Labor	VII	242	0.0163
320	- Utilities	VIII	249	0.0168
330	- Maintenance & Repairs	IX	248	0.0167
340	- Depreciation (not included)	X	---	------
350	- Taxes and Insurance	XI	105	0.0071
370	- Packing Supplies and Expenses	XII	951	0.0642
380	- Inspection and Control	XIII	90	0.0061
390	- Miscellaneous Plant Expenses	XIV	50	0.0034
600 -- General and Administrative Expenses		XV	$ 415	$0.0280
610	- Office salaries		212	0.0143
620-690	- Miscellaneous Expenses		203	0.0137

Table IV -- Raw Material Cost (Account 100)
(Onion Dehydration Plant)

Account No.			Annual Cost	Cost per Operating Day 1/
100	-- Total Raw Material Cost (excluding purchase price of raw material) 2/		$13,956	$93
110	- Purchase Price		-----	---
	The purchase price of raw material is not included here as a cost. See Table I for calculation of raw material costs at various purchase prices per ton			
120	- Buying Expense		9,456	93
	Salary of field agent	$7,000		
	Social security, workmen's compensation, and unemployment insurance - 6.52%	456		
	Expenses - Travel, telephone, etc. (estimated)	2,000		
130	- Field Grading		-----	---
	Assumed grower will pay these operating costs			
150	- Transportation and Weighing Costs		-----	---
	Included in Table I as part of assumed prices paid for raw material			
160	- Storage		-----	---
	No outside storage costs are assumed for this study. There will be many instances, however, where storage costs may be incurred and will become an item of expense			
170	- Crate, Box, and Sack Expense		-----	---
	Cost not included here. On the basis of a cost of $36,000 for sacks and a three-year life with good care, the annual cost would be $12,000			
180	- Federal-State Inspection		4,500	30
	One inspector 150 days at $30			

1/ Annual cost divided by 150 (number of working days)

2/ The total raw material cost used in the processing costs is based on the net 100 tons per day entering the processing line; the cost for the extra 33 tons per day brought to the plant to make a 25% allowance for size-grading loss is not included as it is assumed that the sale of the undersized onions will bring a return sufficient to offset such costs involved

Table V -- Direct Labor Cost Summary (Account 200)
(Onion Dehydration Plant)

Account No.		Per 24-Hour Operating Day: Direct Labor Cost per Day 1/	Add Labor Expense 20.0% 2/	Total Direct Labor Cost
200	-- Total Direct Labor Cost	$2,213	$443	$2,656
210	- Raw Material Handling	230	46	276
220-230	- Preparing	982	197	1,179
240	- Drying	472	94	566
250	- Screening and Inspecting	263	53	316
260	- Packaging and Packing	220	44	264
270	- Warehousing and Shipping	46	9	55

1/ From Table VI

2/ In addition to the "Direct Labor Cost per Day" the following items are additional costs that must be paid by the employer:

		Percentage to apply to Calculated Labor Cost
a.	Overtime - All hours per week over 40 are paid for at one-and-one-half times the basic rate. The work week is 48 hours, making 8 hours to be paid at overtime. For the week he gets 52 hours pay for 48 hours work (52/48) - 1.0 = 0.08333	8.33%
b.	Swing and night shift differential may amount to 5¢/hr. At an average hourly labor rate of $1.28, the differential is 3.90% on two shifts, or an average of 2.60% on a three shift basis	2.60
c.	Social security - paid by employer	1.50
d.	Unemployment insurance - for a new, highly seasonal business, the rate would be	2.70
e.	Workmen's compensation insurance (based upon California rates)	2.32
f.	Vacation pay - none calculated. A typical union contract provides for vacation with pay after the end of the year in which an employee has worked 1600 hours or more. On a six months' operation, the total would be only 1200 hours	----
g.	Holiday pay - with 7 or 8 legal holidays in a year, there would be about 4 holidays in a half-year operation of 150 days 4/150 =	2.67
	Total (round off to)	20.00%

Table VI -- Direct Labor Cost Work Sheet (Account 200)
(Onion Dehydration Plant)

Account No.	Operation	Number of Employees per Shift: Men	Number of Employees per Shift: Women	Hourly Rate of Pay: Pay Bracket	Hourly Rate of Pay: Amount	Total Hours per Shift	Total Cost per Shift	Total Cost per 24-Hour Operating Day
200	-- TOTAL DIRECT LABOR COST	22	51				$737.57	$2,212.72
210	-- Raw Material Handling	6 1/2	--				$ 76.56	$ 229.68
	Foreman 1/	1/2		1	$1.90	4	7.60	
	Operating lift trucks	2		3	1.55	16	24.80	
	Feeding line from bags	2		4	1.42	16	22.72	
	Operating grader	1		5	1.34	8	10.72	
	Cleaning up (also helping with bags, tote boxes, etc.)	1		5	1.34	8	10.72	
220-230	- Preparing	2	32				327.36	982.08
	Foreman 1/	1/2		1	1.90	4	7.60	
	Floorlady		1	5	1.34	8	10.72	
	Coring and trimming		25	6	1.18	200	236.00	
	Inspecting		6	6	1.18	48	56.64	
	Operating slicer 2/	1/2		4	1.42	4	5.68	
	Cleaning up	1		5	1.34	8	10.72	
240	-- Drying	7 1/2	8				157.17	471.52
241	-- Tunnel drying	5	8				126.45	379.36
	Foreman 3/	1/2		1	1.90	4	7.60	
	Feeding trays to tray loading		2	6	1.18	16	18.88	
	Loading trays 2/	1/2		4	1.42	4	5.68	
	Spreading onions on trays		2	6	1.18	16	18.88	
	Tray stacking and truck weighing	1		4	1.42	8	11.36	
	Operating tunnels	2		4	1.42	16	22.72	
	Scraping trays		2	6	1.18	16	18.88	
	Restacking trays		2	6	1.18	16	18.88	
	Sub-total	4	8				122.88	
	Sundays only - Washing trays 4/	(5)		5	1.34	40	53.60	
	- Repairing trays 4/	(1)		5	1.34	8	10.72	
	Sub-total - Sunday only	(6)					64.32	10.72
248	-- Bin drying	2 1/2	-				30.72	92.16
	Foreman 3/	1/2		1	1.90	4	7.60	
	Handling bins	1		3	1.55	8	12.40	
	Handling bins	1		5	1.34	8	10.72	
250	-- Screening and Inspecting	2 1/4	6 1/2				87.88	263.64
	Foreman 5/	1/4		1	1.90	2	3.80	
	Floorlady 6/		1/2	5	1.34	4	5.36	
	Operating screen	1		4	1.42	8	11.36	
	Inspecting		6	6	1.18	48	56.64	
	Cleaning up	1		5	1.34	8	10.72	
260	-- Packaging and Packing	2 1/2	4 1/2				73.44	220.32
	Foreman 5/	1/2		1	1.90	4	7.60	
	Floorlady 6/		1/2	5	1.34	4	5.36	
	Feeding empty cans and collars to line		1	6	1.18	8	9.44	
	Filling and weighing cans		1	6	1.18	8	9.44	
	Compressing into cans, adding recipes, removing collars		1	6	1.18	8	9.44	
	Sealing cans and placing cans in case		1	6	1.18	8	9.44	
	Opening and marking cases	1		4	1.42	8	11.36	
	Strapping and stacking cases	1		4	1.42	8	11.36	
270	-- Warehousing and Shipping	1 1/4	-				15.16	45.48
	Foreman 5/	1/4		1	1.90	2	3.80	
	Storing, car loading, etc.	1		4	1.42	8	11.36	

1/ One foreman for both raw material handling and preparing
2/ One man handles both slicing and tray loading operations
3/ One foreman for all drying operations
4/ Tray washing and repairing done on Sunday only - charge 1/6 of cost to each operating day
5/ One foreman for screening and inspecting, packaging, and warehousing & shipping
6/ One floorlady for inspecting and packaging

Table VII -- Indirect Labor (Account 310)
(Onion Dehydration Plant)

Account No.		Number of Employees	Assumed Yearly Rate	Hourly Rate	Total No. of Hours Employed Annually 1/	Yearly Cost	Cost per Operating Day 2/
310 --	Total Indirect Labor					$36,234	$242
	Year-round employees					28,760	
	Production Supt.	1	$7,000	-	- $7,000		
	Shift Superintendents	2	6,000	-	- 12,000		
	Guards	---	-----	-	- 8,000 3/		
	Labor expense - 6.52% 4/				1,760		
	Seasonal employees					7,474	
	Boiler operator and oiler	3	-	1.73	3,600 6,228		
	Labor expense - 20% 5/				1,246		

1/ 48 hours per week for 25 operating weeks, a total of 1200 hours for each employee

2/ Yearly cost of $36,234 divided by number of operating days, 150

3/ The estimate of $8,000 for guard service is based upon an assumption of 16 hours guard service per day for each day of the year. The number of guards actually employed will depend upon how the guard time is divided among the guards. For example, in a week of 7 days, 16 hours a day, or a total of 112 hours, three guards could divide the time so that each would work about 37 hours

4/

Social security	1.50%
Unemployment insurance	2.70
Workmen's compensation	2.32
	6.52%

5/ See Table V for analysis of 20% labor expense

Table VIII -- Utilities (Account 320)
(Onion Dehydration Plant)

Account No.		B.T.U. per hour	Cu.ft. per day	Cost/Operating Day
320	**Total Daily Cost of Utilities**			$249
321	**Water supply**			----
	400 gallons a minute is estimated need of plant. It is assumed the water will be pumped from company's own well, so cost of pumping is included in cost of power			
322	**Fuel - Gas**			141
	Boiler			
	50% load on 80-horsepower boiler. .5 x 80 x 33,500 B.T.U. per hour x 24 / 80% efficiency x 1,000 B.T.U./cu.ft. =		40,200	
	Drying Tunnels 1/			
	Secondary: 30,000 x 60 x (135-60) x .24 / 15 cu.ft. per pound =	2,160,000		
	Primary: 50,000 x 60 x (160-120) x .24 / 15 cu.ft. per pound =	1,920,000		
	Heat per double tunnel	4,080,000		
	Heat for 4 double tunnels	16,320,000		
	Add 10% for losses	1,632,000		
	Total B.T.U.'s required per hour	17,952,000		
	Gas requirement -- 24-hour day	430,848,000	430,800	
	Total gas requirement per day		471,000	
	At 30¢ per 1,000 cu.ft. the cost is $141			
323	**Electric power**			72
			K.W.	
	Motors - 425 h.p. (746 watts per h.p. and 75% use and efficiency factor) 425 x .746 x .75		237	
	Heating lamps		13	
	Lights		50	
	Total electric power		300	
	Cost per hour @ 1¢ per k.w.h.		$3.00	
	Cost per 24-hour day		$72.00	
325	**Waste disposal**			36
	Garbage disposal - 18 tons "wet waste" per day @ $2.00 a ton disposal cost		$36	
	Sewage Charges - None. Assumed disposal in rural area			

1/ 50,000 c.f.m. of air made up from 30,000 c.f.m. from secondary tunnel, and 20,000 c.f.m. recirculated in primary tunnels

Table IX -- Maintenance and Repairs (Account 330)
(Onion Dehydration Plant)

	Total No. of Employees	Hourly Rate Pay Bracket	Hourly Rate Amount	Hours Worked Process Season 1/	Hours Worked Off Season 2/	Total per Employee	Hours for Group	Total Cost Per Year
Labor 3/								
Head mechanic	1	1	$1.90	1,200	1,080	2,280	2,280	$ 4,332
Shift mechanics and oilers	3	2	1.73	1,200	1,080	2,280	6,840	11,833
Maintenance mechanic	1	3	1.55	1,200	1,080	2,280	2,280	3,534
Sub-total	5							$19,699
Add labor expense - 13% 4/								2,561
						Labor Cost		$22,260
Cost of Supplies and Replacements								
Estimated (for entire year)								15,000
Total Cost of "Maintenance and Repairs" for a year								$37,260
Cost per operating day ($37,260/150)								$249

1/ 25 weeks, 150 days @ 8 hours = 1,200 hours

2/ 27 weeks, 5 days a week, 8 hours a day = 1,080 (includes vacation and holiday pay)

3/ All mechanics will be employed in off-season on maintenance and repair work

4/ Labor expense during processing season 18.68%

Night shift differential: 2 mechanics out of 5 on night shift. Average hourly rate of $1.73, 5¢ an hour differential (2.90% x 2/5) . .	1.16%
Social security	1.50
Unemployment insurance	2.70
Workmen's compensation	2.32
Vacation pay (included in time for off-season)	----
Holiday pay (see Table V)	2.67
Overtime - 52 hours pay for 48 hours work (see Table V) . . .	8.33
Labor expense during off-season	6.52%
Social security	1.50
Unemployment insurance	2.70
Workmen's compensation	2.32
Vacation and holiday pay included in regular 40-hour week . .	----

Calculation of labor expense percentage to apply:

(1,200 hours @ 18.68%) 1,200 x 0.1868 = 224.16

(1,080 hours @ 6.52%) 1,080 x 0.0652 = 70.42

294.58 294.58/2,280 = 12.92%

or 13%

Table X -- Depreciation (Account 340)
(Onion Dehydration Plant)

Depreciation is not included as a cost because of the uncertainty of the write-off period that may be allowed. (See "Business Considerations" in Volume I.) The depreciation charges that would be incurred in this plant are calculated below for two possible write-off periods:

1. Assuming normal life expectancy and probable useful lives (as given in Bulletin F, U.S. Treasury Dept., Bureau of Internal Revenue)

Property Item	Original Cost 1/	Estimated 10% Salvage Value	Cost to be Depreciated	Useful Life (years)	Annual Depreciation Charge
Building and Grounds	$240,000	$24,000 2/	$216,000	50	$ 4,320
Burlap sacks	36,000	None	36,000	3	12,000
Equipment	353,575	35,360	318,215	15	21,210
Total	$629,575	$59,360	$570,215	-	$37,530

Depreciation Charges:

Per operating day ($37,530/150)	$250
Per lb. of product at 7.5:1 (250/17,780)	$0.0141
Per lb. of product at 9:1 (250/14,815)	0.0169
Per lb. of product at 15:1 (250/ 8,890)	0.0281

2/ Assuming 5-year write-off of 75% of capital investment

Total capital investment	$629,575
Less burlap sacks with 3-year life	36,000
	$593,575
75% to be written off	$445,180
Annual charge (445,180/5)	$ 89,040
Add depreciation on sacks	12,000
Total depreciation charge	$101,040

Depreciation Charges:

Per operating day (101,040/150)	$675
Per lb. of product at 7.5:1 (675/17,780)	$0.0380
Per lb. of product at 9:1 (675/14,815)	0.0456
Per lb. of product at 15:1 (675/ 8,890)	0.0759

1/ Includes Engineering Construction fees (Building and Grounds $5,000; Equipment $25,000)

2/ Includes value of land not depreciated

Table XI -- Taxes and Insurance (Account 350)
(Onion Dehydration Plant)

Account No.			Cost per Operating Day
350 -- Taxes and Insurance Expense			$105
For purposes of this estimate, taxes and insurance on property are combined.			
Approximate cost of facilities		$630,000	
Taxes and insurance at 2 1/2%		$ 15,750	
Cost per operating day ($15,750/150)			$105

Table XII -- Packing Supplies and Expenses (Account 370)
(Onion Dehydration Plant)

Account No.			Cost per Operating Day
370 -- Total Packing Supplies and Expenses			$951
Cans			
Allowing 2 1/2 pounds of onions per No. 10 can			
14,815 lbs. daily output/2.5 = 5,926 cans per day @ $99/M			$587
Cases			
988 per day (6 cans per case) @ $299.25/M			296
Supplies			
Straps, glue, recipe sheets, etc. @ 1¢ per can			59
Allowance for losses (1% of $942)			9

Table XIII -- Inspection and Control (Account 380)
(Onion Dehydration Plant)

Account No.			Annual Cost	Cost/Operating Day
380 -- Total Cost, Inspection and Control			$13,507	$90
Salaried Employees:				
Quality Control Technologist		$6,000		
Add labor expense (6.52%)		391	$ 6,391	
Hourly Employees:				
3 laboratory technicians @ $1.30/hr. (3,600 hrs.)		$4,680		
Labor expense (20%)		936	5,616	
Supplies & Other Miscellaneous Expenses			1,500	

Table XIV -- Miscellaneous Plant Expenses & Income (Account 390)

Account No.	Cost/Operating Day
390 -- Miscellaneous Plant Expense	$50
391 - Lunch room operation - Assumed that sales of meals would offset the lunch room expense	---
393 - Sale of trimmings, fines, etc. About 370 pounds of "fines" an hour, or 7,400 pounds a day (20 hour basis), will be produced. This set of plans does not assume any returns from the "fines," as at present the Armed Forces do not purchase it. The "fines" could be ground into onion powder, however, and probably sold to a civilian market. Such a return to the company could be quite substantial. At 25 cents a pound, the return would be $1,850 a day. The selling price of the flakes should take into consideration any returns received from the sale of "fines."	---
394 - Other miscellaneous costs (estimated)	50

Table XV -- General and Administrative Expense (Account 600)

Account No.	Cost/Operating Day
Estimated at 4% of a production cost (of 70¢/lb.)	$415
14,815 lbs. x 70¢ x 4% = $415	
Annual cost ($415 x 150)	$62,250

This estimate is consistent with World War II experience when dehydrators reported General and Administrative Expense ranging from 1% to 15% of total production cost, and averaging between 4% and 5%. This annual cost might be made up as follows:

610 - Salaries	General manager	$10,000			
	Office manager	6,000			
	Personnel officer	4,800			
	Clerks (3 @ $3,000)	9,000	$29,800		
	Labor expense (6.52%)		1,940	$31,740	
620-690 - Other Expenses				30,510	$62,250

CHAPTER VI

SUMMARY OF CAPITAL AND CREDIT REQUIREMENTS FOR A 100-TON PER DAY ONION DEHYDRATION PLANT

Fixed Capital and Credit Requirements:			
Plant Equipment		$365,000	
Buildings and Grounds		235,000	
Construction Engineering Fees		30,000	
6-month General Expense: (From "Production Costs")			
From Table IV - Raw Material Procurement . .	$ 4,700		
From Table XIII - Inspection & Control . .	8,800		
From Table XV - General Administration	31,500	45,000	$ 675,000
Operating Capital and Credit Requirements:			
Estimated Advance Payments to Growers, Insurance, Utilities, etc.		$ 25,000	
75-day Operating Costs ($10,371/operating day) 1/		778,000	
75-day Supply of Stored Onions (estimated at $40/ton)		300,000	
25-day Inventory of Manufacturing Supplies (exclusive of raw commodity) ($951/operating day)		24,000	1,127,000
	Sub-total		$1,802,000
General Contingency Fund:			
Equivalent to approximately 10% of Estimated Capital Requirements			180,000
ESTIMATED TOTAL CAPITAL AND CREDIT REQUIREMENTS			$1,982,000

1/ Based on 14,815 lbs. dehydrated onion flakes per day at an approximate cost of 7¢/lb.

FIG. 1 — USUAL PLANTING AND HARVESTING PERIODS FOR ONIONS IN PRINCIPAL PRODUCING STATES

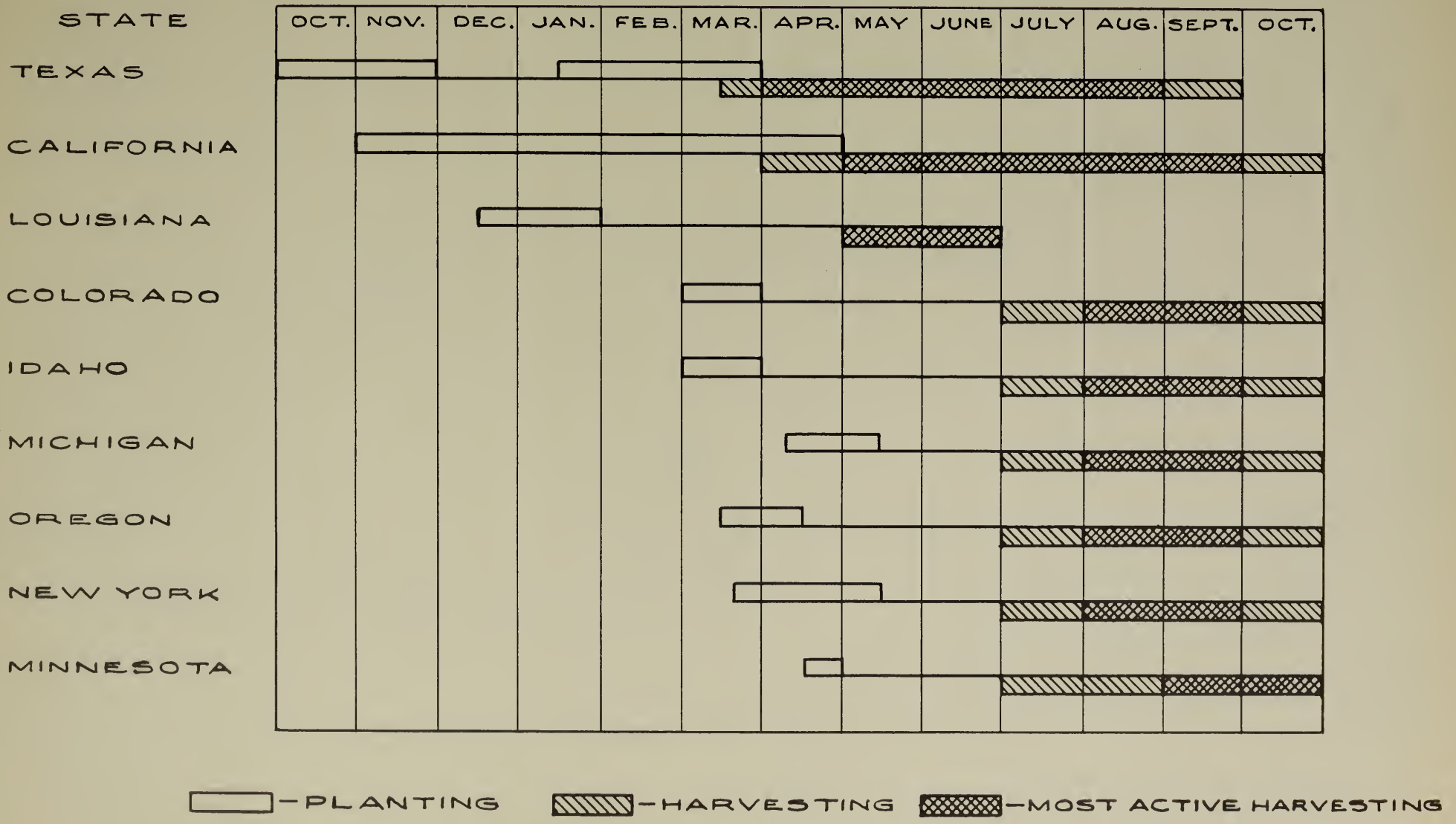
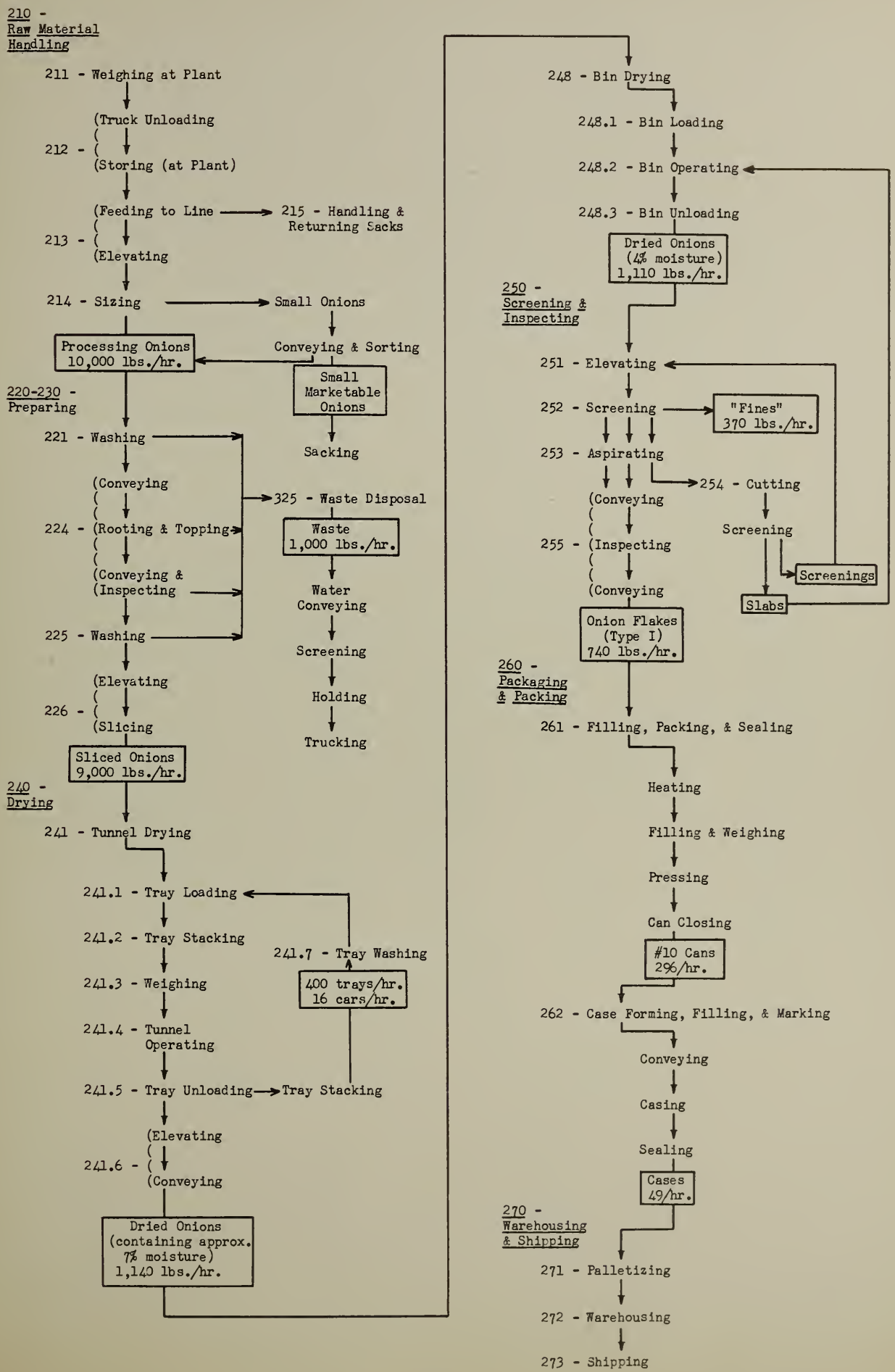
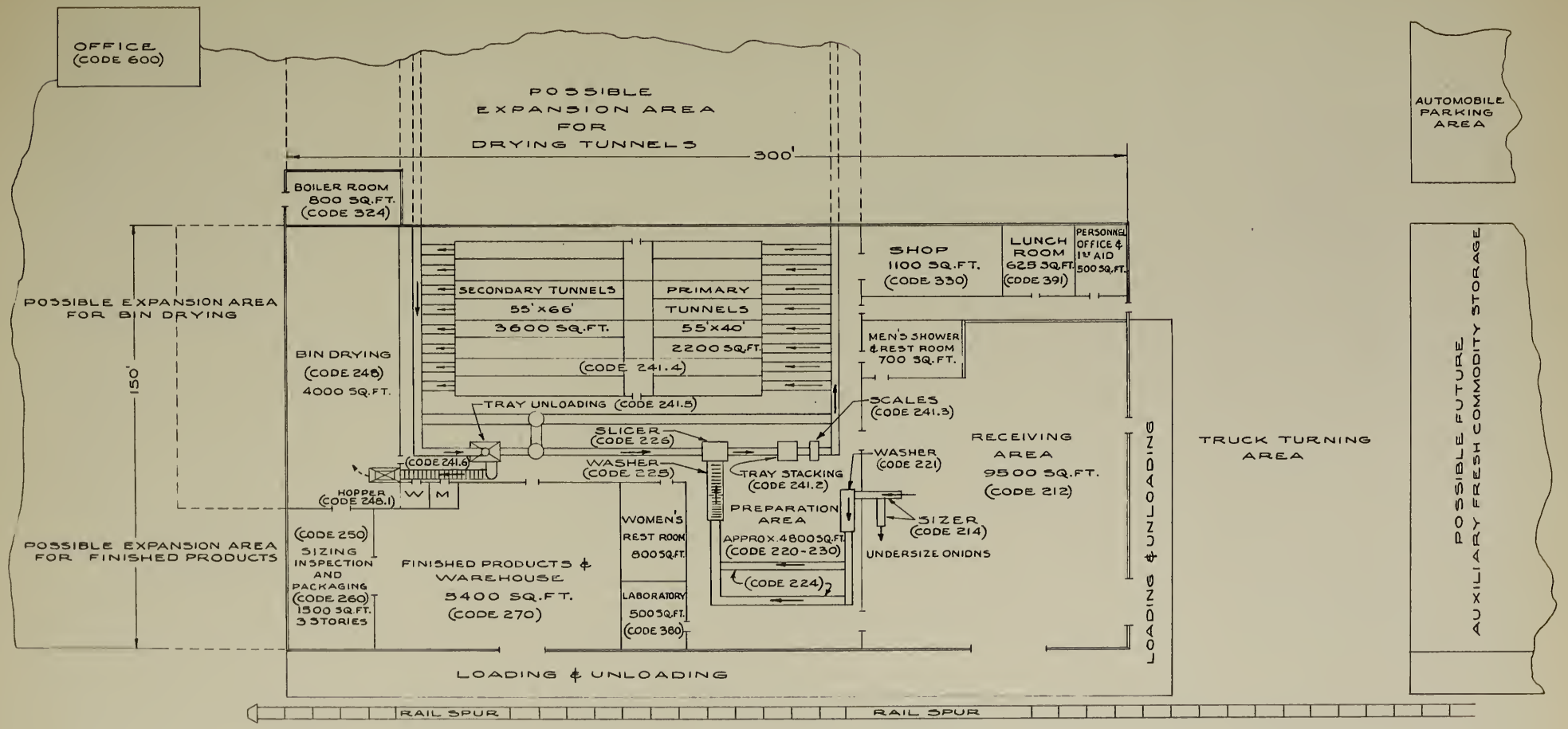


Figure 2 - FLOW SHEET FOR ONION DEHYDRATION
(Capacity - 100 Raw Tons per Day)



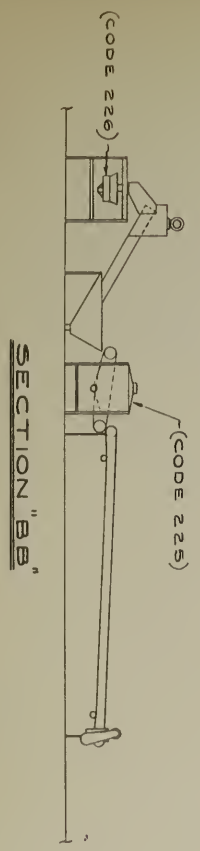


PROPOSED FLOOR PLAN FOR ONION DEHYDRATING PLANT

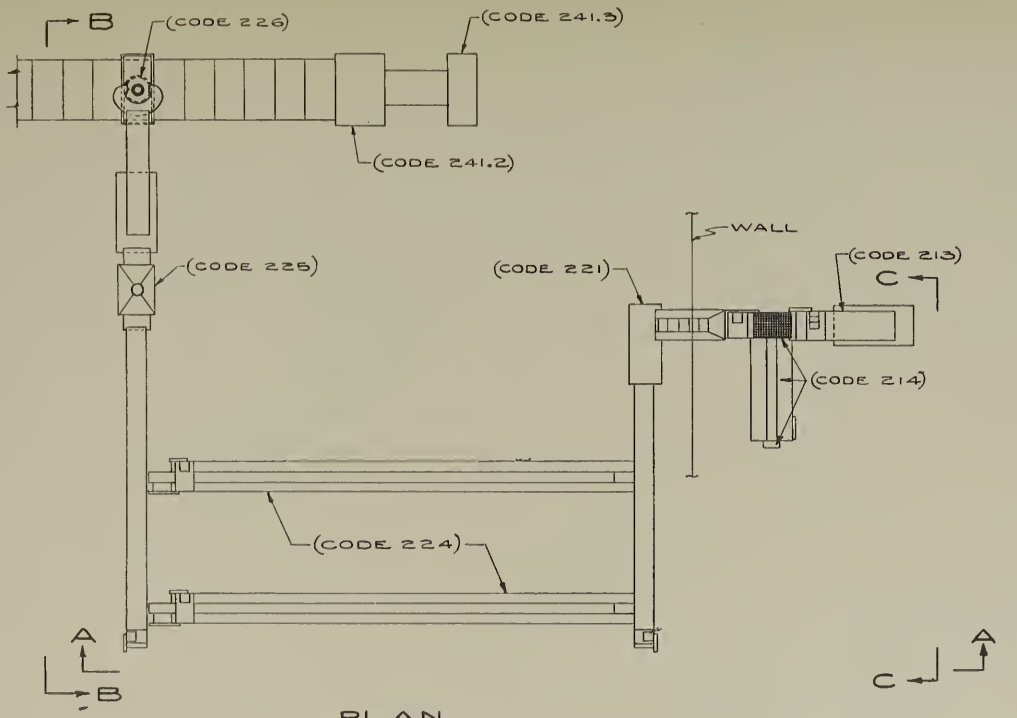
AREA 47,000 SQ.FT.

0 5 10 15 20 25 50 FT.

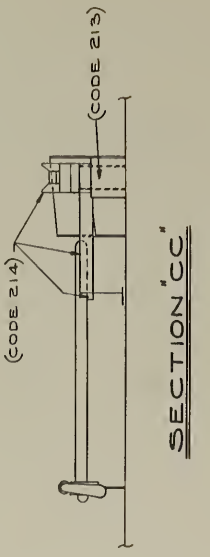
FIGURE 3



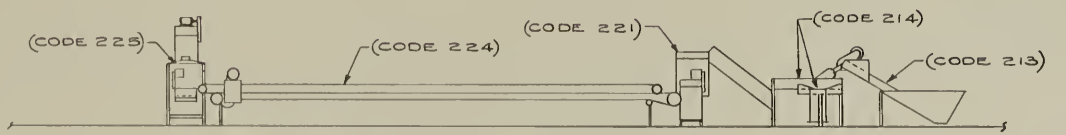
SECTION "BB"



PLAN



SECTION "CC"



FRONT ELEVATION - SECTION "AA"

LEGEND

CODE 213	ELEVATOR (FEEDING TO LINE)
214	SIZER, CONVEYOR, BAGGER (SMALL MARKETABLE ONIONS)
221	WASHER
224	TRIMMING AND CORING TABLE
225	WASHER
226	SLICER
241.2	TRAY STACKER
241.3	SCALES

FIGURE 4

PREPARATION LINE FOR ONION DEHYDRATION PLANT.

GENERAL NOTES

1. DAMPER TO REGULATE FLOW OF FRESH AIR TO SECOND STAGE
2. COMBUSTION CHAMBER FOR SECOND STAGE
3. BLOWER FOR SECOND STAGE
4. SHUT-OFF DAMPERS (TWO)
5. DAMPER TO REGULATE FLOW OF FRESH AIR TO PRIMARY STAGE
6. COMBUSTION CHAMBER FOR PRIMARY STAGE
7. BLOWER FOR PRIMARY STAGE
8. SHUT-OFF DAMPERS (TWO)
9. DAMPERS TO REGULATE FLOW OF RECIRCULATING AIR (TWO)
10. EXHAUST STACKS (TWO)
11. OVERHEAD SLIDING DOORS (TWO)
12. ACCESS DOORS (TWO)
13. ENTRANCE AND EXIT DOORS (4 SETS)
14. TRAYS OF RAW COMMODITY READY FOR DRYING (ON TRUCKS)
15. TRACKS THROUGH TUNNELS FOR TRUCKS
16. SPLITTER DAMPERS (TWO)

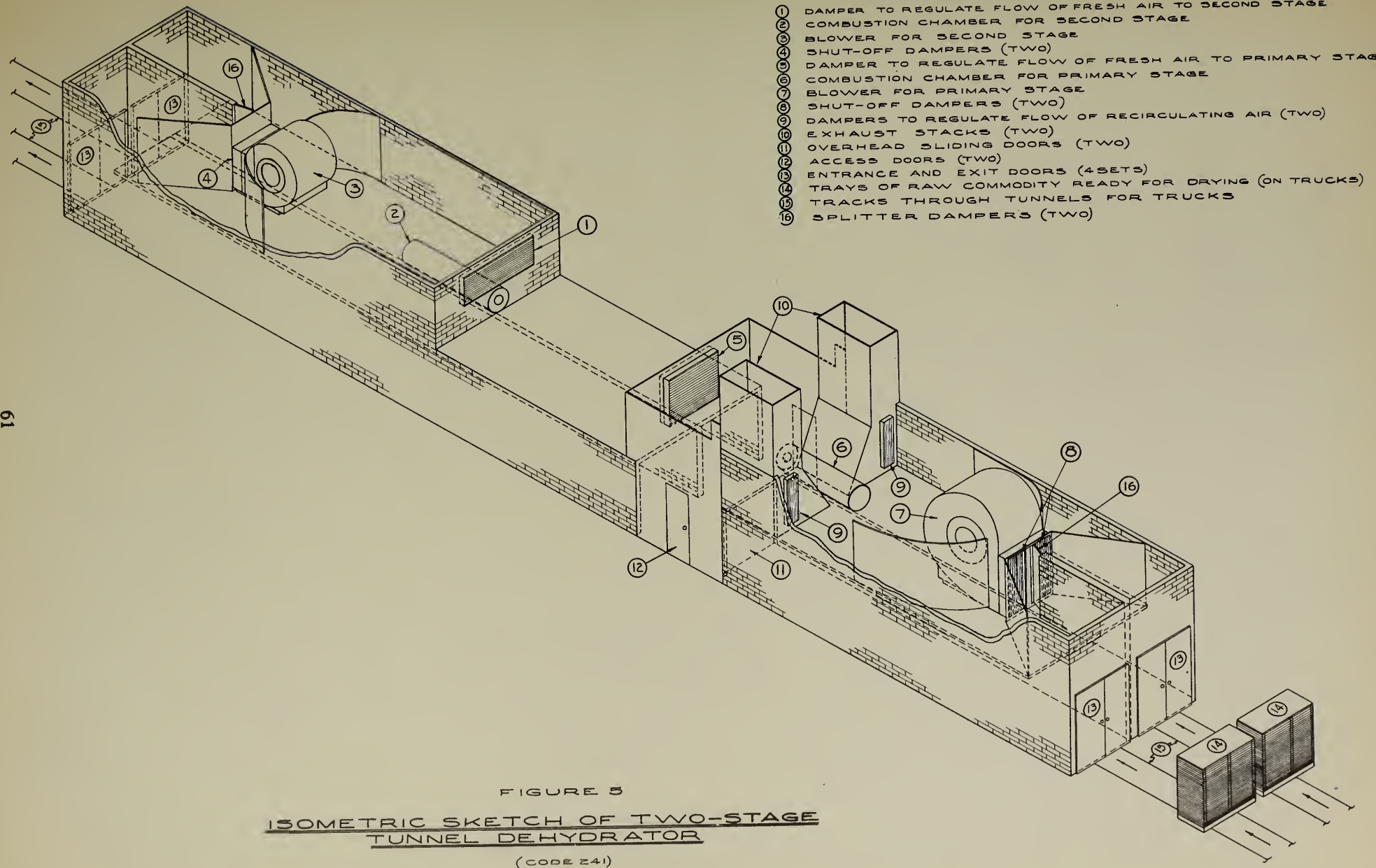
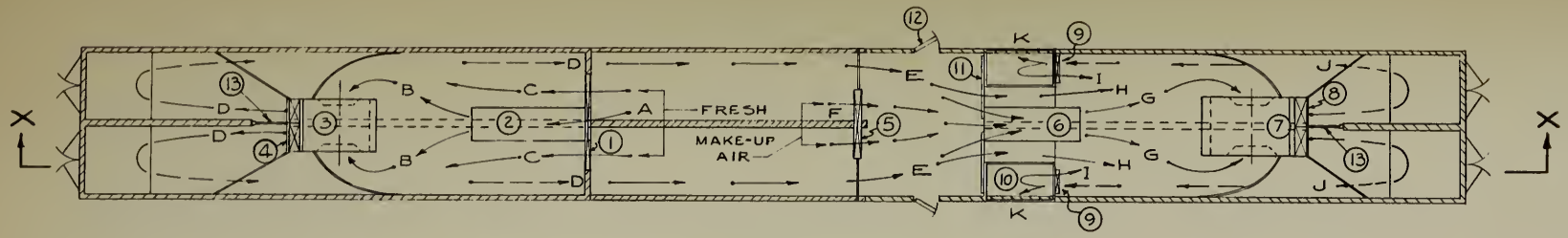


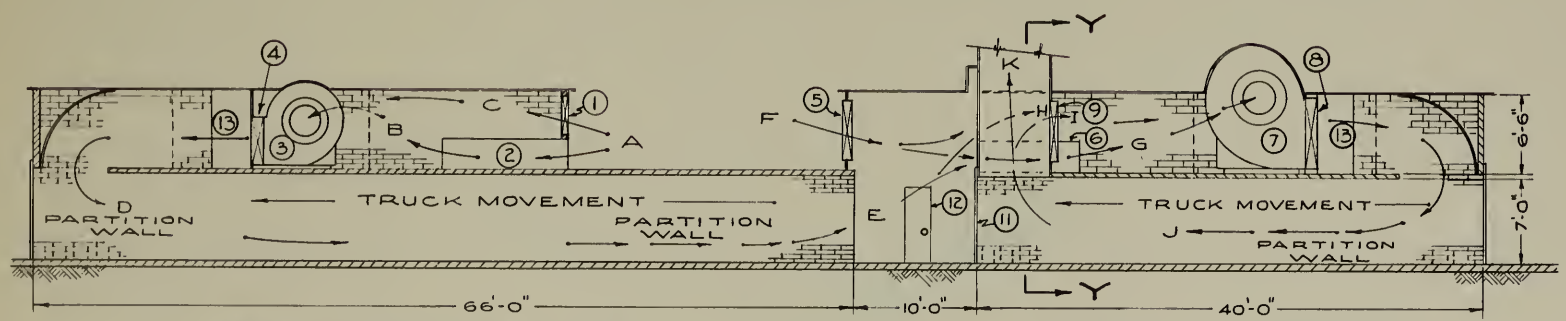
FIGURE 5

ISOMETRIC SKETCH OF TWO-STAGE TUNNEL DEHYDRATOR

(CODE 241)



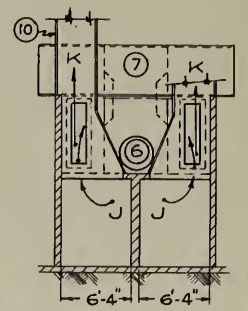
PLAN BELOW ROOF LINE



SECONDARY STAGE

PRIMARY STAGE

SIDE ELEVATION — SECTION "X X"



SECTION "YY"

GENERAL NOTES

1. DAMPER TO REGULATE FLOW OF FRESH AIR TO SECOND STAGE
2. COMBUSTION CHAMBER FOR SECOND STAGE — 4,000,000 BTU/HR.
3. BLOWER, FOR SECOND STAGE - ACCEPTABLE MODEL STURTEVANT SILENTVANE FAN, DESIGN 10, CLASS I, SIZE 95, DWDI, 20HP. MOTOR
4. SHUT-OFF DAMPERS (TWO)
5. DAMPER TO REGULATE FLOW OF FRESH AIR TO PRIMARY STAGE
6. COMBUSTION CHAMBER FOR PRIMARY STAGE — 6,000,000 BTU/HR.
7. BLOWER FOR PRIMARY STAGE — ACCEPTABLE MODEL STURTEVANT SILENTVANE FAN, DESIGN 10, CLASS I, SIZE 115, DWDI, 40 H.P. MOTOR.
8. SHUT-OFF DAMPERS (TWO)
9. DAMPERS TO REGULATE FLOW OF RECIRCULATING AIR (TWO)
10. EXHAUST STACKS (TWO)
11. OVERHEAD, SLIDING DOORS (TWO)
12. ACCESS DOORS (TWO)
13. SPLITTER DAMPERS (TWO)

AIRFLOW NOTES

- A - FRESH MAKE-UP AIR TO SECOND STAGE
- B - HOT AIR FROM SECOND STAGE COMBUSTION CHAMBER
- C - FRESH MAKE-UP AIR BY-PASSING SECOND STAGE COMBUSTION CHAMBER
- D - CONTROLLED TEMPERATURE, SECOND STAGE DRYING AIR
- E - EXHAUST AIR FROM SECOND STAGE
- F - FRESH MAKE-UP AIR TO PRIMARY STAGE
- G - HOT AIR FROM PRIMARY STAGE COMBUSTION CHAMBER - MIXTURE OF FRESH MAKE-UP AIR AND EXHAUST AIR FROM SECOND STAGE.
- H - AIR BY-PASSING PRIMARY STAGE COMBUSTION CHAMBER - MIXTURE OF FRESH AIR AND EXHAUST AIR FROM SECOND STAGE
- I - RECIRCULATED AIR FROM TUNNEL EXHAUST
- J - CONTROLLED TEMPERATURE, PRIMARY STAGE DRYING AIR
- K - EXHAUST AIR FROM TUNNEL, TO OUTSIDE

FIGURE 6

TWO-STAGE TUNNEL DEHYDRATOR FOR ONIONS.

(CODE 248)

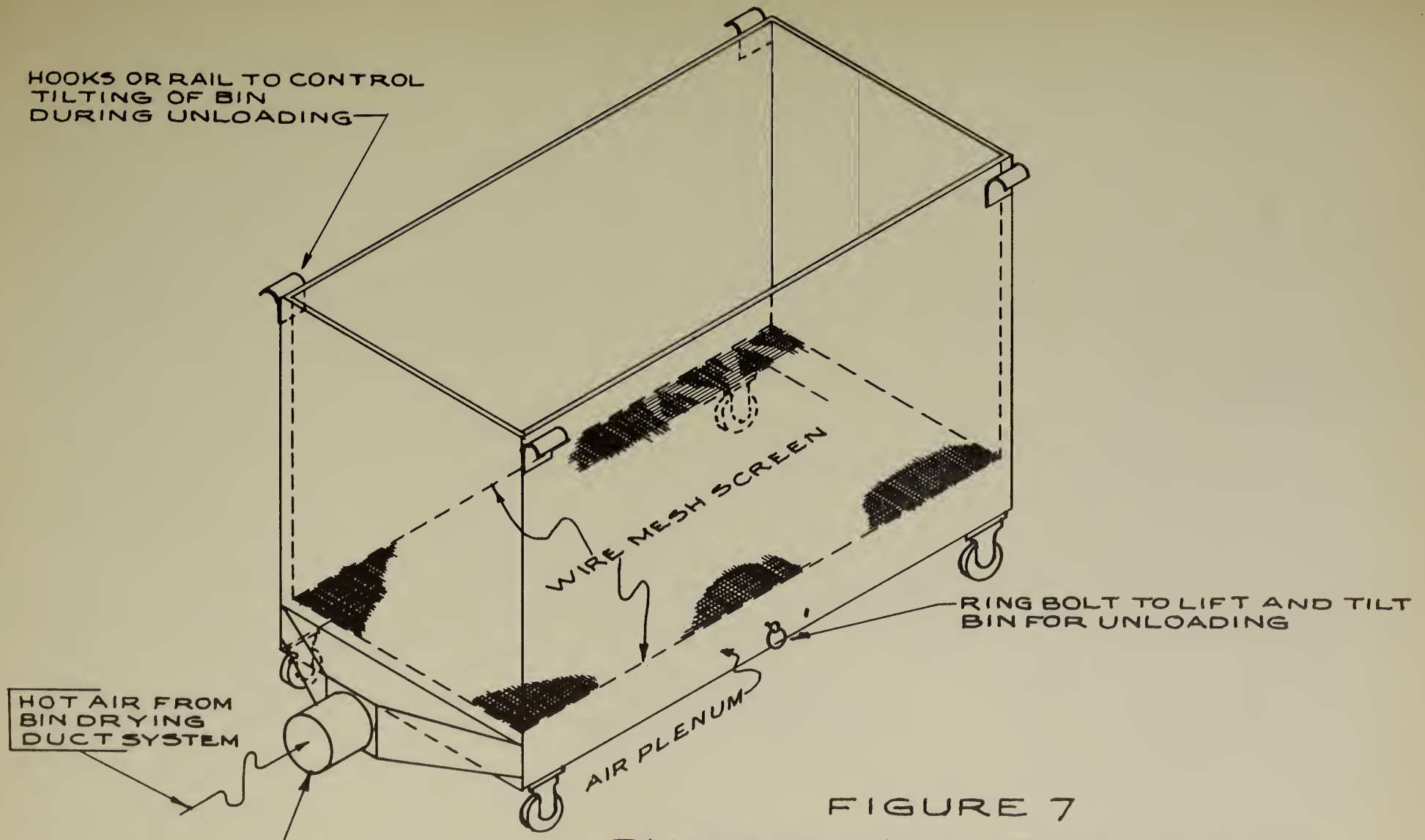


FIGURE 7

DIAGRAMMATIC SKETCH OF PORTABLE BIN FINISHER

(CODE 248.1)

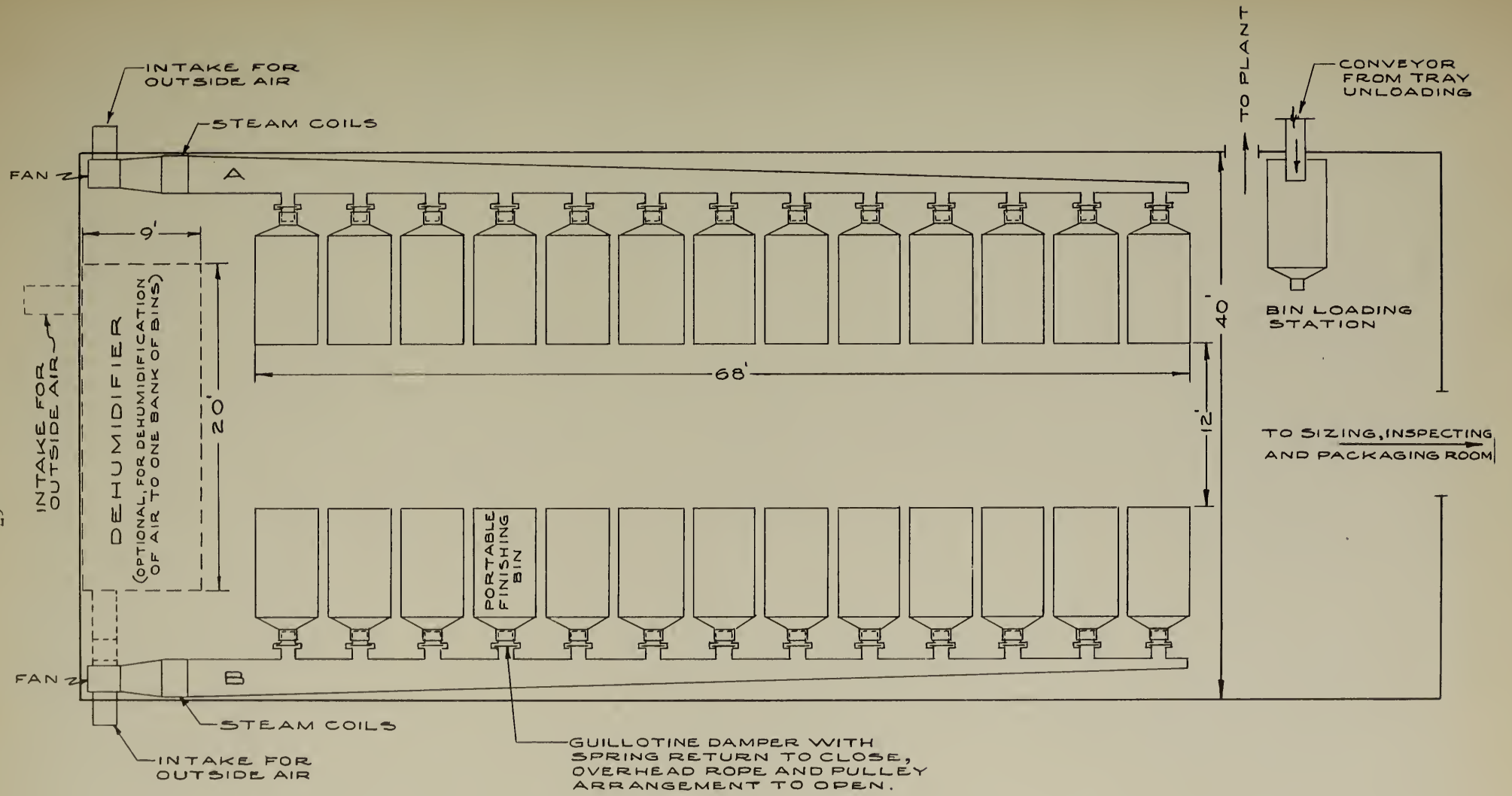
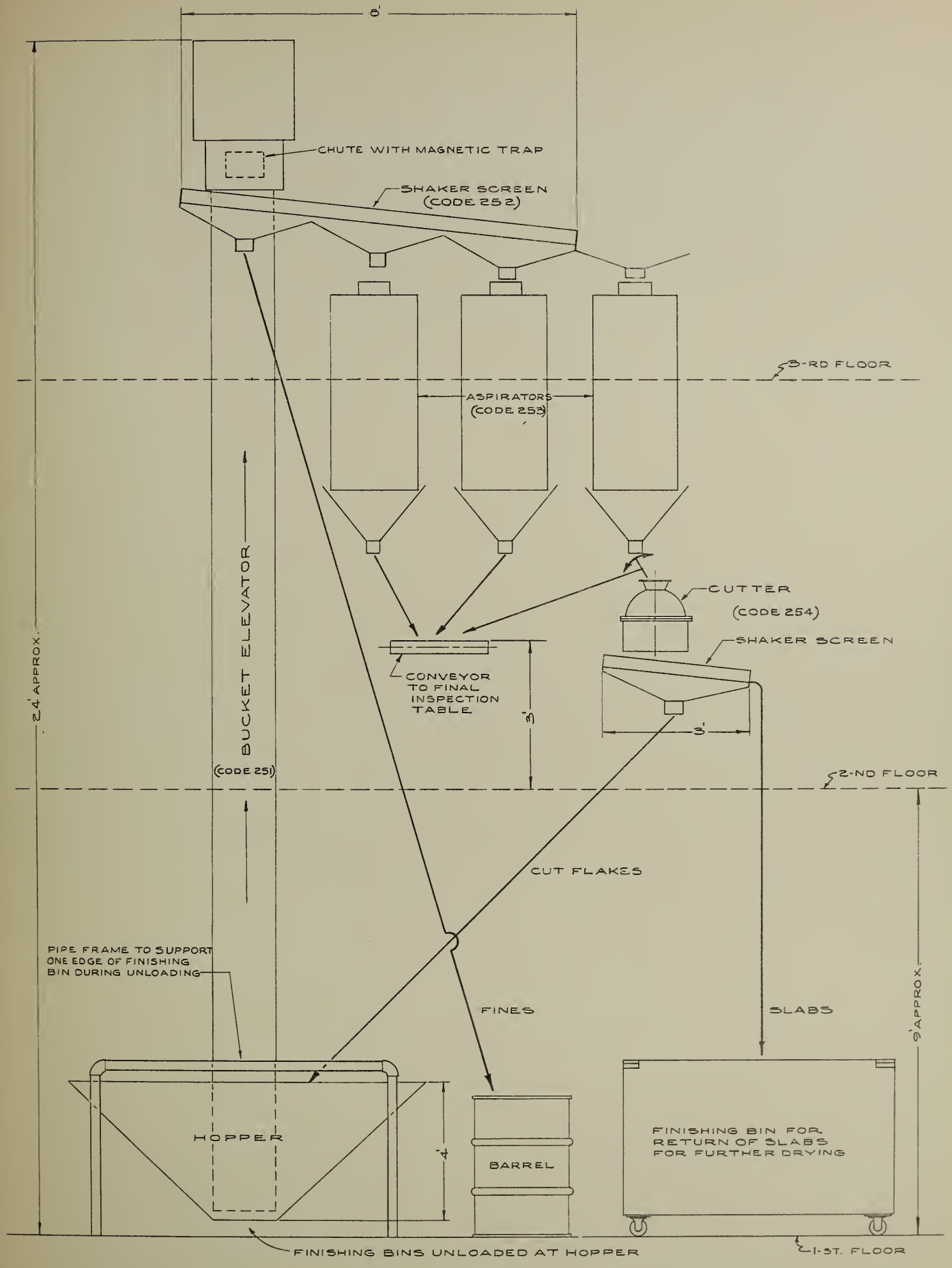


FIGURE 8

LAYOUT OF BIN FINISHING ROOM FOR ONION DEHYDRATION PLANT

(CODE 248)



LAYOUT OF SCREENING & ASPIRATING EQUIPMENT FOR DEHYDRATED ONIONS.

FIGURE 9
(CODE 250)

GPO 86-093910